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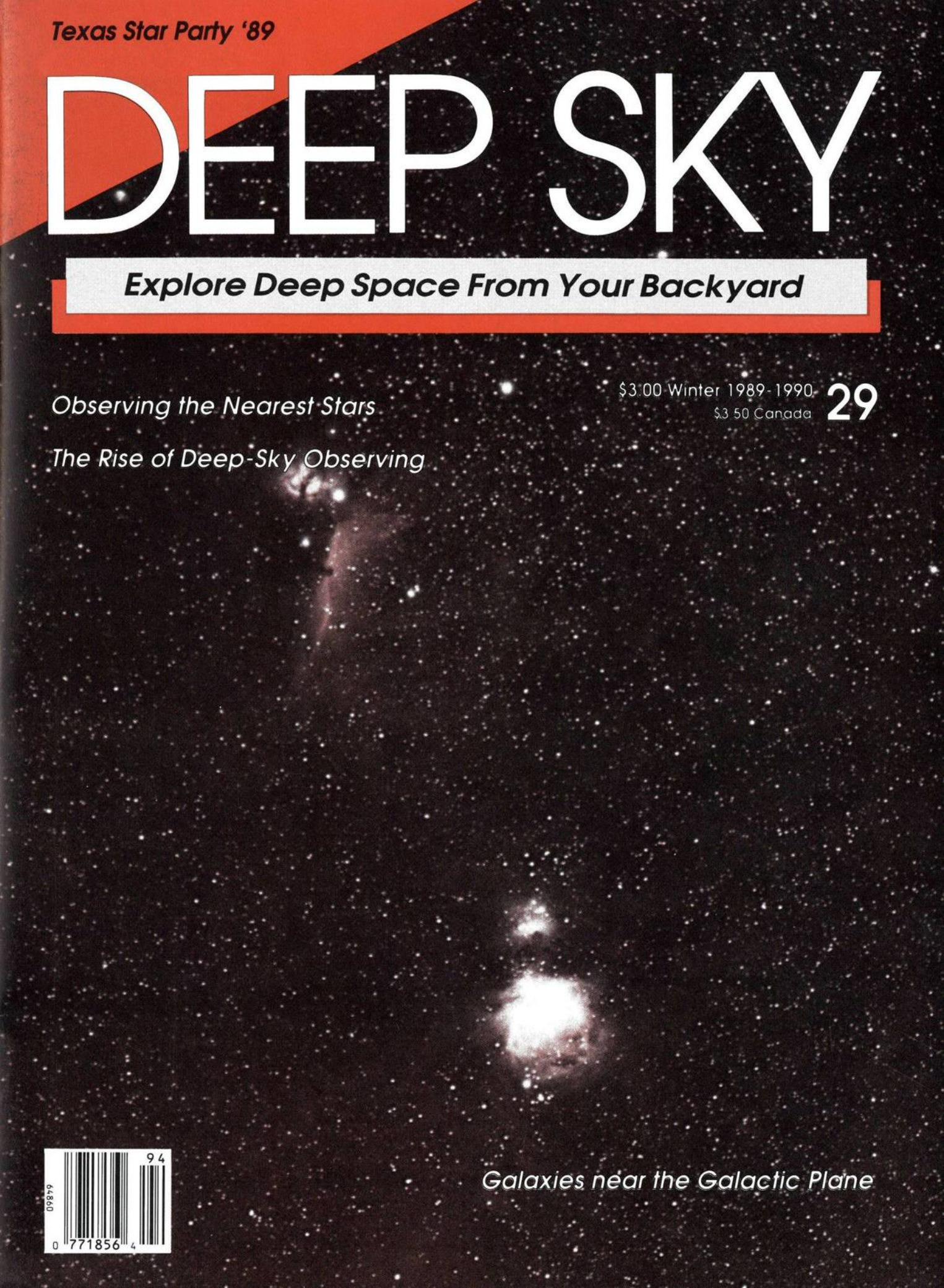

Galaxies near the Galactic Plane

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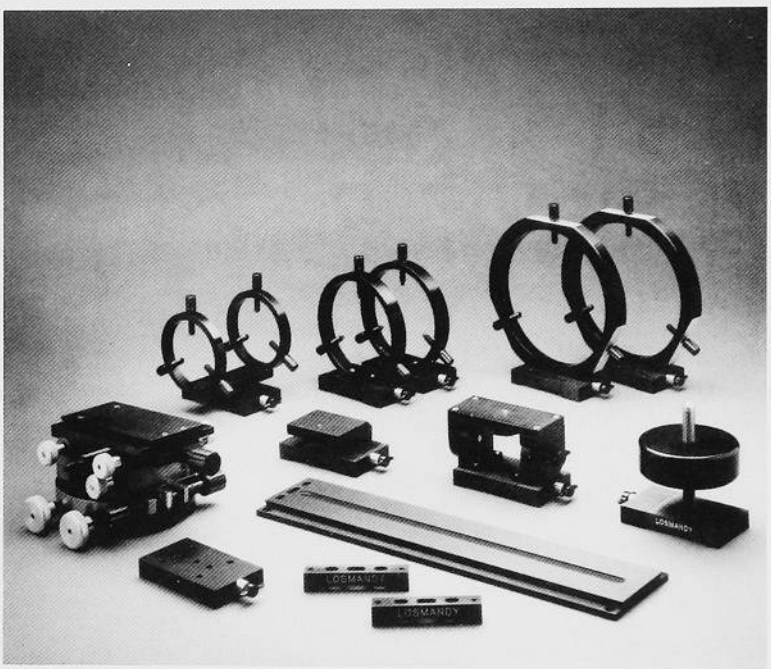

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DEEP SKY

THE MAGAZINE FOR DEEP-SKY OBSERVERS AND ASTROPHOTOGRAPHERS WINTER 1989-1990 VOLUME 8, NUMBER 1

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by Ernie Ostuno
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Observing Nearby Stars
by Joe Caruso
14 *Some of the most interesting objects in the sky are stars that lie near us in the Galaxy. Yet few observe them because they require detailed finder charts. Joe Caruso supplies the charts and the background information on these fascinating objects.*

The Rise of Deep-Sky Observing
by Ray Harris
18 *Just how did humans discover and record deep-sky objects on early star atlases? Ray Harris studies a question long neglected and offers examples of early star charts.*

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Cover: Regions of the Winter Milky Way like lower Orion are surprisingly full of faint galaxies. Ronald Royer used a 4-inch f/5 astrograph. Opposite page: Kim Zussman photographed the core of M42 with an 11-inch f/10 SCT, hypered Tech Pan, and a 3-minute exposure.

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At the Eyepiece
Beating the Winter Blues

The Winter Blues are here again. That time has come when telescopes sit untouched and observers drift away from fever-pitched sessions at the eyepiece to reading about their favorite activity. If weather prevents you from getting outside often, we hope our issue will spark you into action despite the weather. Ernie Ostuno's article on galaxies along the winter Milky Way offers little-known objects to track down and record. Joe Caruso demonstrates how easy it is to trek outside and find some nearby stars — those that might be visited first by Earth craft at some distant time in the future. And Ray Harris illuminates the neglected subject of the rise of deep-sky objects on early star atlases. We hope that this rather diverse group of stories — along with the regular departments — will help keep your spirits high as you long for a warm spring!

Dave Eicher
Editor

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Letters to *Deep Sky*
Catch a Double near the Ring

The double star GP 192 lies approximately 20" from the nebula and serves as a challenging test of telescope resolution. Photo by Jack Marling (24-inch f/15.2 Cassegrain, Fujichrome 400 film, 20-minute exposure).

Double Star near the Ring Nebula

Dave / Enclosed is a print from my files of M57 taken by Jack Marling (specs engraved on back!) showing the double star GP192 near the Ring Nebula. I mentioned this star in the Summer issue (#27). The pair lies toward the upper right (about 2 o'clock) of the nebula, 43mm from the central star.

As an observational follow-up to the article, Fred Mrozek and I viewed the faint planetary M1-64 at the Texas Star Party using a "demo" 7-inch Starfire refractor. The nebula and its nearby 15th-magnitude star were faintly visible despite relatively poor seeing and thin cirrus. Desiring a truly satisfying view, we walked down the field and commandeered Tom Clark's 25-inch Newtonian. It effectively cut through the clouds and showed the object as an obvious ring — the minature ring nebula in Lyra!

Brian Skiff
Lowell Observatory
1400 West Mars Hill Road
Flagstaff, AZ 86001

Greetings from The Netherlands

Dear Mr. Eicher / I am an enthusiastic reader of your magazine and enjoy the beautiful artwork presented by highly skilled U.S. and Canadian astrophotographers. I live in a heavily populated and light-polluted area, so I envy those amateurs who can observe the sky under more favorable conditions. Nevertheless, about a year and a half ago I started taking photos with my 8-inch f/6 Newtonian reflector, and I enclose some of my recent results.

In the Spring 1989 (#26) issue Steve Coe requested photos and observations of objects in Gemini, including the planetary nebula NGC 2392, the Eskimo Nebula. I enclose a shot of the Eskimo Nebula made on Technical Pan film, showing fine details in the object. This print is a 35x enlargement of the original negative.

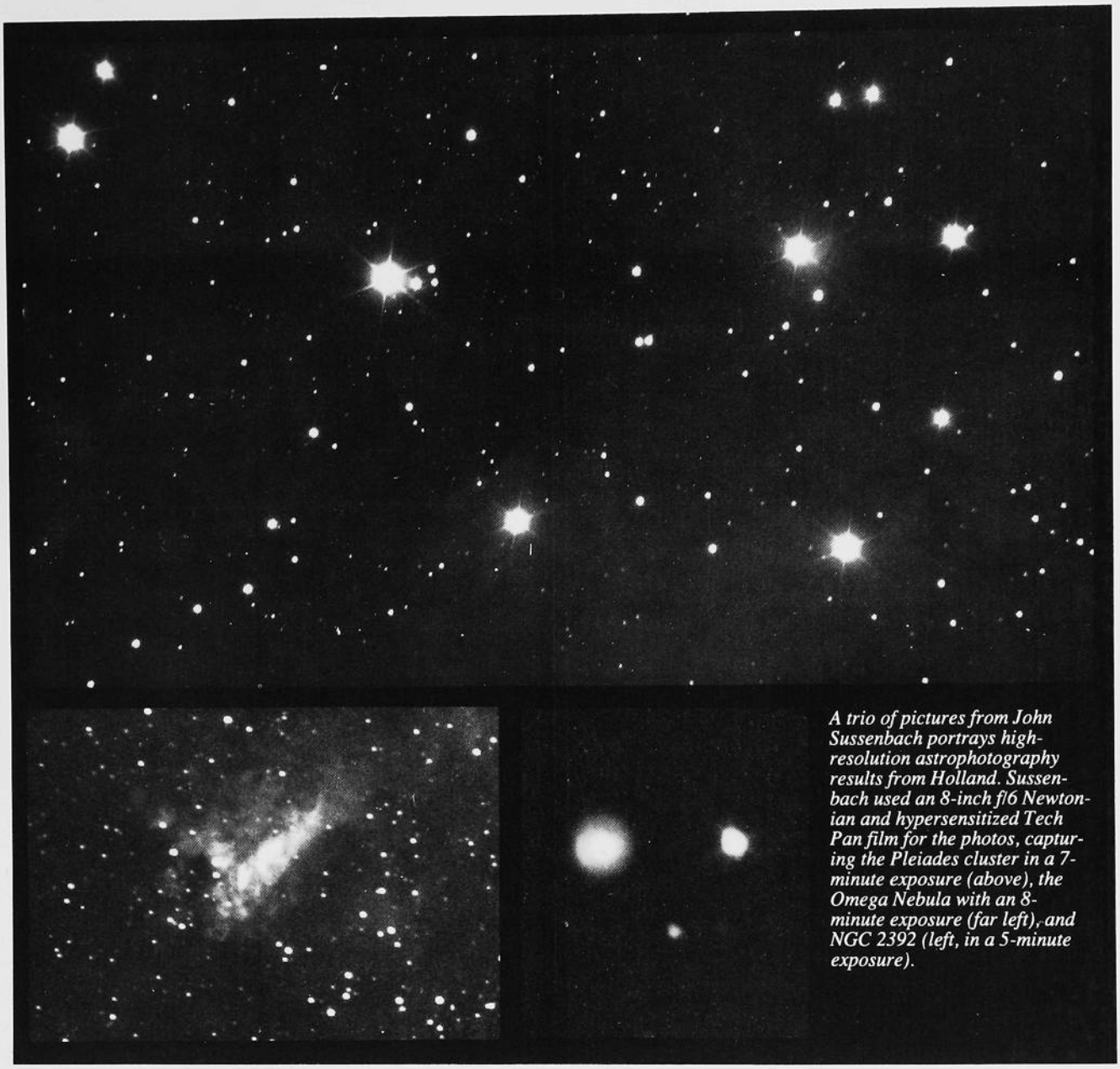
The other photos represent what I can achieve at my observing site. In general I can expose no longer than 15 or 20 minutes without fogging the film.

I hope you and your readers enjoy the photos.

John S. Sussenbach
Park Arenberg 42
3731 ET De Bilt
The Netherlands

The Galaxies Near M13

Dear Dave / I'd like to clarify the identities of the galaxies less than 1° southeast of M13 discussed by Robert Bunge in the Summer 1989 issue (#27). The trio from north to south consists of IC 4614, NGC 6196, and NGC 6197; and the brightest of the three is the centrally located NGC 6196. Although not men-



A trio of pictures from John Sussenbach portrays high-resolution astrophotography results from Holland. Sussenbach used an 8-inch f/6 Newtonian and hypersensitized Tech Pan film for the photos, capturing the Pleiades cluster in a 7-minute exposure (above), the Omega Nebula with an 8-minute exposure (far left), and NGC 2392 (left, in a 5-minute exposure).

tioned by Bunge, 13th-magnitude NGC 6196 also has an extremely faint and small companion just 1' southwest that is barely detectable in my 17.5-inch scope. Also, there appears to be a mix-up in the article between angular sizes (arcseconds and arcminutes) and also in converting right ascension into angular separations.

Steve Gottlieb
1020 Ramona Avenue
Albany, CA 94706

Cheaper Galaxies

Dear Dave / I enjoyed your favorable review of Prof. B. A. Voronstov-Velyaminov's book *Extragalactic Astronomy*. It is an excellent book that admirably displays the author's knowledge of his subject matter. I found his popular writing style quite soothing — he's my kind of science writer!

However, you should inform the readers of *Deep Sky* that the book's price to individuals is $85, not the institutional price (the standard price given) of $285.

The book may be Vorontsov-Velyaminov's final great achievement, because the Professor is eighty-five years old and is now in failing health. He deserves to be heard.

Udo J. Schlegel
Rockford Amateur Astronomers, Inc.
427 Shaw Street
Rockford, IL 61104

Zussman Tweaks

Dear Dave / There were a few errors in my article on hypersensitization in the summer *Deep Sky* (#27). The caption to the plot of image density versus log exposure should indicate rectangles for the 10-minute development. In this type of graph, increased film speed results in a shift to the left since less exposure is required to reach the same density.

Near the top of the third column, the sentence, "The film is then exposed to the mixture of gases in a vacuum environment so that harmful oxygen and water, which reduce the effectiveness of hypering, are drawn away from the film," is unclear. The point here is that the emulsion is outgassed prior to baking in forming gas by baking under a vacuum. I have now reduced the hypering time by a factor of three by using a good vacuum provided by a Welch Duo-Seal pump for 1.5 hours before introducing forming gas.

In the caption at the bottom of page twenty-four, the description should indicate more grain in the 10-minute developed exposure, although the difference is hardly noticeable as stated in the text.

I hope these points will help clarify the article, and I'll look forward to future issues with anticipation.

Kim Zussman
3275 Big Sky Drive
Thousand Oaks, CA 91360

Galaxies Near the Winter Milky Way

by Ernie Ostuno

The luminous band of the Milky Way meanders a full 360° around the celestial sphere, its hazy glow cutting the sky into halves. This is the view we get from inside a large spiral galaxy. Galileo was the first to use optical aid to inspect the Milky Way, confirming the belief that it was composed of countless faint stars.

To the modern amateur astronomer this is the prime hunting ground for galactic deep-sky objects: open clusters, globular clusters, and planetary gaseous nebulae. The galaxies beyond are effectively blocked from view by thick clouds of gas and dust in our Galaxy's disk, creating a zone of avoidance in which galaxies may be detected only by their strong radio emissions.

How many spectacular face-on spirals like M51 or edge-on systems like NGC 4565 lie hidden in the zone of avoidance? We'll probably never know, although several noteworthy nearby galaxies have been discovered close to the galactic plane, including Maffei I and Maffei II.

After reading about these enigmatic objects a few years ago, I became interested in finding out how close to the plane of the Milky Way could external galaxies be observed with amateur telescopes, in my case 10-inch and 13-inch reflectors. In *A Field Guide to the Stars and Planets*, Donald Menzel mentioned a window in the obscuring clouds of galactic dust that allowed NGC 6822 in Sagittarius to be readily observable. How many other such windows might be open along the path of the Milky Way?

Those of you who have observed most of the bright NGC and IC galaxies may be ready for a new challenge. To tackle these objects, you'll need the usual: dark skies, a keen eye, and a moderate-sized telescope. Photographic charts such as the *Palomar Sky Survey (POSS)* help immensely in locating and observing these objects, because they show you exactly where to look

In this first of two articles on galaxies near the Milky Way, we'll explore the winter Milky Way from Scorpius to Cassiopeia. Unfortunately for observers in the Southern Hemisphere, there is a "zone of avoidance" between Scorpius and Puppis that occurs in this northern-biased study.

Because many of these galaxies are faint and obscure, it is fortunate that there are usually prominent objects nearby, such as bright stars, star clusters, or nebulae. Appropriately enough, we'll begin our search in the environs of one of the most famous Milky Way vistas — the Double Cluster in Perseus. Although this part of the sky offers some fine clusters, the galactic dust is relatively thin, allowing the feeble light of many faint galaxies to shine through.

From the Double Cluster star-hop about 2° southwest to NGC 744, a coarse open cluster of about twenty-five stars. Half a degree southeast lies XX Persei, a reddish variable star ranging in magnitude from 8.6 to 9.4. Due west of this star, in the same low power field of view, is **Zwicky 559.004**, a tiny, 15th-magnitude spiral. In a 13.1-inch scope at high power, this galaxy appeared as nothing more than a small spot of light, even using averted vision.

Moving south away from the galactic plane, the galaxies become progressively brighter. **UGC 2261** is an elliptical galaxy glowing dimly at magnitude 15.2. In the same telescopic field lies **UGC 2270**, an Sb-type galaxy with a magnitude of 14.8. Both of these galaxies can be found about half a degree west-northwest of PK 141-7.1, an extremely faint planetary nebula that unfortunately is plotted in *Uranometria 2000.0* slightly east of its actual position.

Continuing south, we find the 14th-magnitude galaxy **IC 257**, a fairly easy object in the 13-inch scope. **IC 260**, a smaller and fainter galaxy, can be found in the same low-power field, due east of IC 257. Continue east about three degrees and you'll find the relatively conspicuous **NGC 1169**. In a 10-inch scope this object appears as a large, round, diffuse glow, visible with direct vision.

The main concentration of the Perseus Cluster of galaxies lies a few degrees south. A separate article would be required to cover the dozens of faint galaxies within a few degrees of Algol; so I'll only mention a couple of the brighter outlying members. **IC 278**, a small, high surface brightness elliptical, can be found a degree southwest of Rho Persei. **NGC 1167** is slightly brighter and lies 2.5° further south. In the 10-inch scope **NGC 1167** is a bright, round object and appeared to me to be one of the brighter galaxies in Perseus, despite a published magnitude of 14.0.

Because the galactic dust thickens in Auriga, galaxies are harder to come by. In the western part of the constellation lies Palomar 2, a heavily obscured, distant globular cluster. A little more than 2° east-southeast of this cluster is Barnard 28, an unusual, Z-shaped dark nebula. Just to the south is van den Bergh 31, a faint reflection nebula that is plotted in *Uranometria 2000.0*. Paradoxically, 1° south from these obscuring dust clouds is a galaxy. **UGC 3205** with a listed magnitude of 16.0 would seem impossible to detect in an amateur scope. Its appearance on the *POSS*, however, convinced me that it was brighter than 16.0. I managed to observe UGC 3205 with the 10-inch scope and later confirmed this observation with the 13-incher. I estimated its brightness at about magnitude 15.5.

A much easier galaxy lies north of Beta Aurigae, which marks the northeastern point of the pentagon of Auriga. **UGC 3374** may be found half a degree northeast of IC 2149, a small disklike planetary nebula. At magnitude 13.9 this barred spiral is one of the brightest galaxies in Auriga. In the 10-inch scope UGC 3374 appeared as a small, faint, elongated patch visible with averted vision. After you spot this galaxy, star-hop north to the small open cluster NGC 2126. On the northeastern edge of this cluster, you'll find a 6th-magnitude star, and just northeast of this star is **Zwicky**

Several faint galaxies lie strewn across southern Orion. Photo by Martin C. Germano (135mm f/2.5 lens, hypered Tech Pan film, 50-minute exposure).

Could you find a galaxy in this picture? Auriga the Charioteer is home to a collection of UGC and other faint galaxies. Photo by David Healy (50mm f/1.8 lens, Fujichrome R100 film).

232.005. At magnitude 15.5 this tiny spiral is barely detectable with a 10-inch scope, high power, and averted vision. With the 13-inch it's still difficult, but I found it interesting to compare the cluster, several thousand light-years distant, with the galaxy, many millions of light-years away. Talk about depth of field!

Travel eastward to the open cluster NGC 2281; galactic dust is no longer a problem. However, there is still a dearth of bright galaxies. **UGC 3525** is about 1° southwest of NGC 2281. This galaxy glows at magnitude 14.9 and appears in the 10-inch scope as a small, faint blob.

By now your eyes should be fully dark adapted. This will be necessary for our next couple of galaxies. We begin our survey of Gemini by finding M35. From there, star-hop to Mu Geminorum, one of the stars marking the feet of Gemini. If you have a large scope and a nebular filter, you may want to observe IC 443, a large, faint supernova remnant lying between Mu and Eta Geminorum. From Mu, move 1° southeast to **Zwicky 115.001**, which is itself just southeast of a pair of 9th-magnitude stars that are plotted in *Uranometria 2000.0*. This tiny elliptical galaxy glows dimly at magnitude 15.4. I suggest using high power and at least a 10-inch scope to observe it.

An easier target can be found about 1.5° east-northeast of Epsilon Geminorum. **UGC 3555** is a 14th-magnitude spiral that is visible in a 10-inch as a pretty small, faint, round dot. Several companion galaxies lie nearby, including a very small system in contact on the north-eastern edge of UGC 3555. A large telescope and high power may show this feeble object.

Your eyes may be a bit strained at this point, so we'll move on to something a little easier. **NGC 2341** and **NGC 2342** form a fine pair of interacting galaxies that can be found 1° east of Zeta Geminorum. NGC 2342 is a 12th-magnitude distorted spiral and is much larger and brighter than NGC 2341. NGC 2341 is a small peculiar-type galaxy just southeast of NGC 2342. Both galaxies were visible in the same medium-power field of view with the 10-inch scope. Less than 2° south is **NGC 2339**, a large Sc galaxy. In the 13-inch scope this object appeared like a round, diffuse glow, easily visible with direct vision.

Crossing the galactic equator into Orion, set your scope on Betelguese and star-hop to NGC 2141, a rich open cluster of faint stars. From here, move 2° northwest and look for **NGC 2119**, an elliptical galaxy with a magnitude of 15.0. It lies close southwest of a 9th-magnitude star. Using a medium- to high-power eyepiece, center the star in the field of view and, imagining that due north is at "12 o'clock," look for a faint, round glow at the "5 o'clock" position.

After spotting NGC 2119 move on to Bellatrix, the star marking Orion's left (western) shoulder. Less than 1° north-

Canis Major hides several faint galaxies behind its veil of dust. Large telescopes can pick them out. Photo by Brad Wallis (50mm f/2.8 lens, GAF 200 film, 30-minute exposure).

west of the star, you'll find Dolidze 17, a cluster of five bright stars arranged in a distorted X shape. Less than 0.5° south is **NGC 1875**, a small S0 galaxy of magnitude 15.2. In the 13-inch scope this object showed up well under high power, which I found advantageous because of its small size. When observing this galaxy, keep in mind that it's light is actually shining through a very faint veil of gaseous nebulosity, a part of the vast complex that permeates most of Orion. From NGC 1875 it's a quick hop to **NGC 1819**, a barred spiral of magnitude 13.7. This galaxy was visible with direct vision in the 13-inch scope.

Of course, no journey through Orion is complete without observing the Great Nebula. This time, however, there's a twist. We're going to use M42 as a point of reference to starhop to a galaxy. **NGC 1924** is a fairly bright spiral lying less than 2° due west, and it is one of the best kept secrets of the winter sky. I found it to be an easy target for the 10-inch scope and now make a point of observing it whenever I look at M42.

Another fairly easy object for large scopes is **NGC 2110**, which can be found 2° northeast of Saiph, the star marking Orion's right knee. The light of this 14th-magnitude elliptical manages to shine through even thicker dust clouds than the previously mentioned galaxies.

If the galaxies in Orion are dimmed by obscuring dust, then those in Monoceros are all but blotted out. There are a few galaxies in the Unicorn, however. **UGC 3630** can be found in the eastern part of the constellation near the Canis Minor border. In the 13-inch scope it was visible with averted vision as a very faint smudge of light. Another difficult object is **MCG-01-19-001**, a small edge-on spiral that lies between two 6th-magnitude stars. Located in the dense star fields of the Monoceros Milky Way, these galaxies are targets for big scopes.

Faint galaxies lie scattered across the immediate region of the Double Cluster in Perseus. Photo by Jack Metcalfe (135mm f/4 lens, hypered Tech Pan film, 15-minute exposure).

NGC 2377, a reasonably bright Sb-type spiral, lies about 4° south. Although this galaxy is listed as a "class 7" (nonexistent) object in the *RNGC*, inspection of the *POSS* shows that this galaxy does indeed exist among the many star clusters and nebulae of this region. In the 10-inch scope NGC 2377 appeared as a faint glow set amidst the rich, starry background of the Milky Way.

Continuing on a southerly trek down the galactic plane, we enter Canis Major, a constellation that, besides containing scores of star clusters and the brightest star in the sky, holds a number of galaxies. We can begin by star-hopping from Sirius to the nearby **NGC 2296**. Once you've located the field of the galaxy, switch to high power to cut down on the glare from Sirius and examine this small, 13th-magnitude elliptical.

NGC 2283, a 13th-magnitude barred spiral, can be found about 1° southwest. This galaxy was a nice sight in the 13-inch scope, appearing as a large amorphous glow with slight central brightening set against a rich starfield. About nine degrees south is a nice triple system of galaxies. **NGC 2292** and **NGC 2293** are two 13th-magnitude ellipticals in contact, while **NGC 2295** is an edge-on spiral just to the west. All three galaxies are visible in the same field of view with the 10-inch scope.

Our next reference point is Epsilon Canis Majoris, also known as Adhara. **NGC 2325** is a bright elliptical located less than 1° to the northeast of this star. This is an easy galaxy in a 10-inch scope, but observers in more northerly latitudes may want to wait until it is well up in the sky to cut down on the effects of horizon skyglow. When NGC 2325 is near the zenith, you can drop about 1° to the south-southwest to find the little-observed **IC 456**. This SB-type galaxy has a magnitude of 15.0, but the nucleus and bar have almost stellar surface brightnesses. With a clear southern horizon and at least an 8-inch scope, look for this object just southwest of a 9th-magnitude star.

Eta Canis Majoris is the next reference star. Two degrees due west is a galaxy that was listed as a planetary in the Perek-Kohoutek catalogue of planetary nebulae. **ESO 428-G14** is plotted in *Uranometria 2000.0* (as a galaxy). In the 13-inch scope with averted vision, I glimpsed this 15th-magnitude object just northeast of a triangle of 9th- and 10th-magnitude stars. **NGC 2380**, about 1° due north of Eta Canis Majoris, is a much easier target. In the 13-inch scope this elliptical was visible as a small, hazy oval in a rich field of faint stars. You won't often see a galaxy this bright surrounded by so many field stars.

The final constellation we'll investigate is Puppis, the stern of the good ship (and former constellation) Argo Navis. Well known to Southern Hemisphere observers, Puppis does offer a few treasures to northern dwellers, including many obscure galaxies. It is one of those rare constellations that contains all five types of deep-sky objects. The least known are its galaxies.

One of the brightest of these is **NGC 2525**, a galaxy lying close to the Monoceros border. Despite its listed magnitude of 12.3, this galaxy did not appear bright in the 13-inch scope. It was round with little central brightening, appearing similar to a faint planetary nebula. About 1° southwest is **NGC 2517**, an object just southeast of a 10th-magnitude star. Continue in this direction two more degrees and you'll come to **NGC 2501**, a 14th-magnitude spiral. All these galaxies have rich starfields surrounding them.

Five degrees southwest of NGC 2501 is NGC 2440, our next reference point. From the pale blue disk of this planetary, star-hop a little over 1° southwest to a 9th-magnitude star that's plotted just northwest of the radio source 0745-188 in *Uranometria 2000.0*. Center this star in the field and switch to high power. Once again imagine that due north is at "12 o'clock" and look in the "4 o'clock" position for a narrow, faint streak of light. This is the 14th-magnitude galaxy **MCG-03-20-001**, an edge-on spiral located a mere 3° from the plane of the rich Puppis Milky Way.

NGC 2566 is a 13th-magnitude barred spiral that can be found by star-hopping from Rho Puppis. Only 7' due north of NGC 2566 is **IC 2311**, a 14th-magnitude elliptical with a high surface brightness. Both objects were visible in the same field of view with the 13-inch scope. With a very large scope you may notice two small companion galaxies southwest of IC 2311. About 2° further south is 13th magnitude **NGC 2559**, a galaxy partially hampered by the 10th-magnitude star that lies on its eastern edge.

From here we cross the galactic equator and head into the deep southern skies for our final two galaxies. **NGC 2427**, at about the same declination of Omega Centauri, is too far south for most U.S. observers. Indeed, even from Texas, I found the horizon glow detracts from this large, low surface brightness spiral. From what I did see of it, however, I would imagine it to be quite impressive from areas where it can be seen well up in the sky. **NGC 2310** offers somewhat better prospects, as its surface brightness is higher and it lies farther north. Look for a large, elongated object due west of an 8th-magnitude star. Even though it will withstand high powers, little detail will be revealed to northern observers due to its low declination.

Now that you've read about these objects, the next step is observing them. Although this will be considerably more difficult, it's also a lot more fun. Don't be scared by the faint magnitudes given for many of these galaxies. By using good charts and driving well out into the country, I've been able to find galaxies as faint as magnitude 15.5 with a 10-inch telescope. The key to observing very faint objects is knowing their exact position relative to the field stars surrounding them. Then you can use averted vision to full advantage to bring these faint fuzzies out from the sky background.

Ernie Ostuno is an avid galaxy hunter living in Cheshire, Connecticut.

Observing Nearby Stars

by Joe Caruso

Galaxy hunters and nebula photographers are usually inattentive to our own neighborhood, which offers an array of challenging and interesting sights for the backyard astronomer. Like tourists who long for the far-away and exotic, we tend to think of our own region of the Galaxy as somewhat mundane and well-explored.

But as you read this, astronomers are exploring the nearby universe at full tilt, investigating the ever-increasing possibility that planets orbit some nearby stars. Examples include the *IRAS* discoveries of "something" around Beta Pictoris and Vega and the recent brown dwarf candidate orbiting Wolf 630-VB8B discovered by Ron Probst and D. W. McCarthy.

Ordinarily, stars close to home are defined as those extending out to a distance of five parsecs (16.5 light-years). (See Alan H. Batten's list in the *Observer's Handbook* of the Royal Astronomical Society of Canada, and this author's (with George Lovi) map in the September 1982 *Sky & Telescope* for a list of some sixty-five separate stars in forty-nine systems.) The standard reference work, the *Catalog of Nearby Stars* by Wilhelm Gliese (1969), contains data for 915 star systems out to a distance of 22 parces and has been extended (1978) by Gliese and Jahreiss to 25 parsecs, increasing the total to 1,209 stars.

Additionally, various specialty lists have been compiled by investigators. Examples include Vysottsky's list based on spectroscopy of all K8-M5 dwarfs and Groombridge's treatment of close stars lying near the North Celestial Pole. Presently, nearby stars are being researched most actively with the 61-inch astrometric telescope at Flagstaff's U.S. Naval Observatory and the telescopes at Van Vleck Observatory in Connecticut, Yale University, Leander-McCormick in Virginia, and Alleghany near Pittsburgh.

From these lists I have culled only those close stars that are of observational interest in small telescopes for one reason or another and have included a few that lie somewhat farther away, because of some noteworthy feature. All of the very closest stars out to 61 Cygni are included.

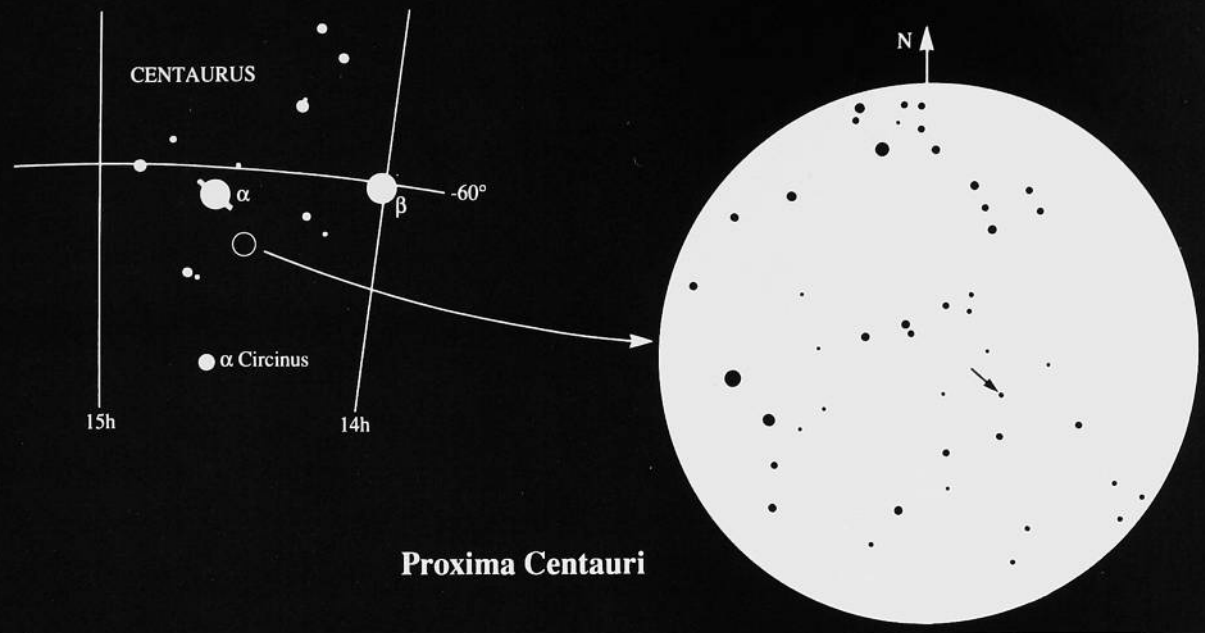
The charts for these stars have been hand drawn, based on the finder cards used for the parallax program for the 20-inch Clark refractor at Van Vleck. These finder cards were originally copied by John Booth from the *Palomar Sky Survey*. Bright stars in the solar neighborhood (Sirius, Altair, etc.) need no finder charts because even inexperienced observers will have no trouble finding them. Examining the list, you can see most of the nearby stars are very faint and very red, so sometimes color alone will identify the star for you once you have located the field. Also, the notes direct observers to other (and maybe better!) sources of information and charts.

As an astronomy teacher, I have always been surprised how, next to the face of the Moon and Saturn's rings, students are really excited by the prospect of planets orbiting around Barnard's star or by the uniqueness of Eta Cassiopeiae, with its sunlike primary and red dwarf companion. Students are particularly intrigued when I mention that, if mankind ever does travel to the stars, it will certainly be to one of these fascinating neighbors of the Sun.

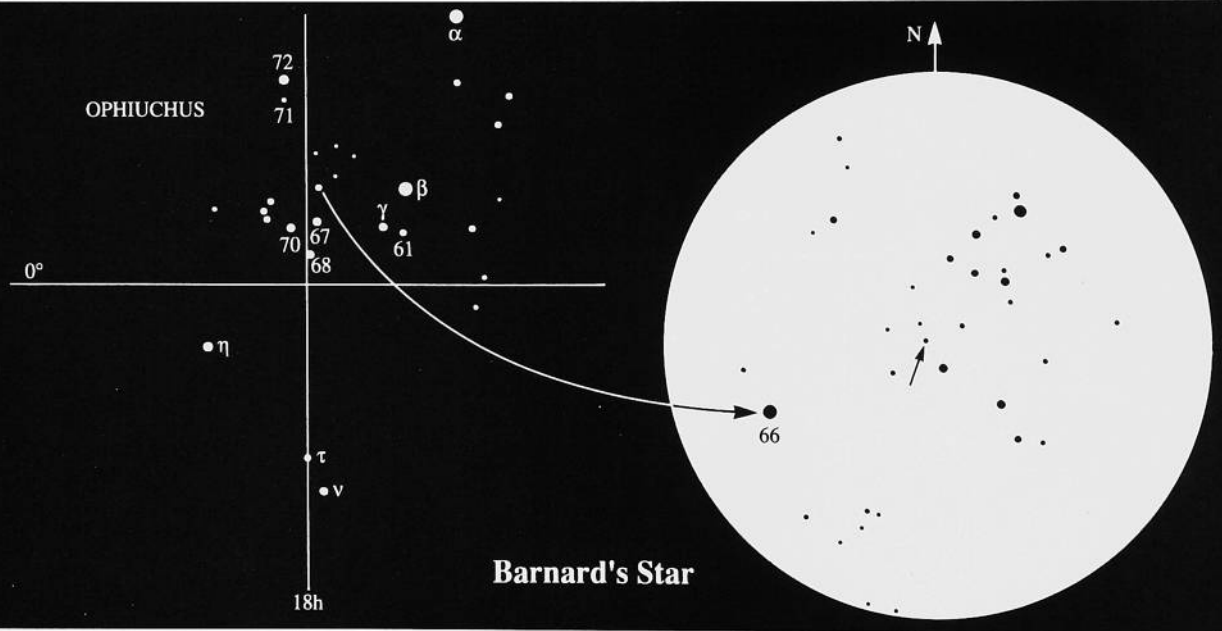
Joseph Caruso is chief telescope operator at Van Vleck Observatory at Wesleyan University in Middletown, Connecticut. He also teaches astronomy classes at Wesleyan and the University of Hartford.

The Closest Systems

Star	R.A.(2000.0)Dec.	Spec.	Mag.	Dist.
α Centauri A	14h40m -60°50'	G2V	-0.01	4.3
α Centauri B	14h40m -60°50'	KIV	1.33	4.3
Proxima Centauri C	14h30m -60°41'	M5V	11	4.3
Barnard's Star	17h58m +4°39'	M4V	9.5	5.9
Wolf 359	10h57m +7°03'	M6V	13.5	7.7
Lalande 21185	11h03m +36°02'	M2V	7.5	8.2
UV Ceti	0h39m -17°58'	M6V	12.5	8.4
UV Ceti B			13.0	8.4
Sirius A	6h45m -16°43'	AIV	-1.41	8.6
Sirius B			8.3	8.6
Ross 154	18h50m -23 °50'	M4	10.5	9.4
Ross 248	23h42m +44°11'	M5	12.3	10.4
ε Eridani	3h33m -9°28'	K2V	3.7	10.8
Ross 128	11h48m +0°50'	M4	11.1	10.9
61 Cygni A	21h07m +38°05'	K4V	5.2	11.1
61 Cygni B		K5V	6.0	11.1
Other Nearby Stars				
Procyon A	7h39m +5°13'	F5IV	0.4	11.4
Procyon B			10.7	11.4
τ Ceti	1h44m -15°56'	G8V	3.5	11.8
Kruger 60A	22h28m +57°41'	M3V	9.8	12.9
Kruger 60B		M3V	11.3	12.9
van Maanen's Star (Wolf 28)	0h49m +5°25'		12.3	14.1
o^2 Eridani A	4h15' -7°39'	KIV	4.4	15.7
o^2 Eridani B			9.5	15.7
o^2 Eridani C		M4V	11.1	15.7
70 Oph	18h05m +2°30'	KOV	4.2	16.1
		K4V	6.0	16.1
Altair	19h51m +8°52'	A7V	0.8	16.5
η Cas A	0h46m +57°33'	GOV	3.5	18
η Cas B		MO	7.3	18
Groombridge 1830	11h50m +38°05'	G8	6.5	28
Groombridge 34	0h15m +43°44'	M4	10.9	11.7
Lacaille 9352	23h3m -36°09'	M2	7.4	11.9



Proxima Centauri



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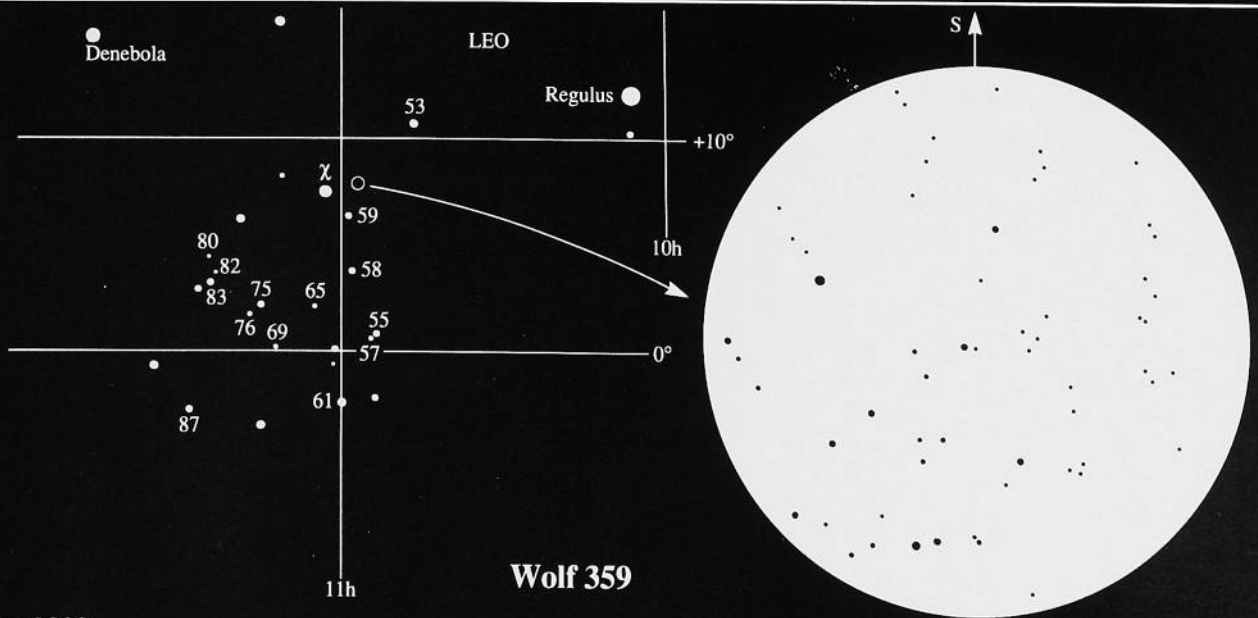
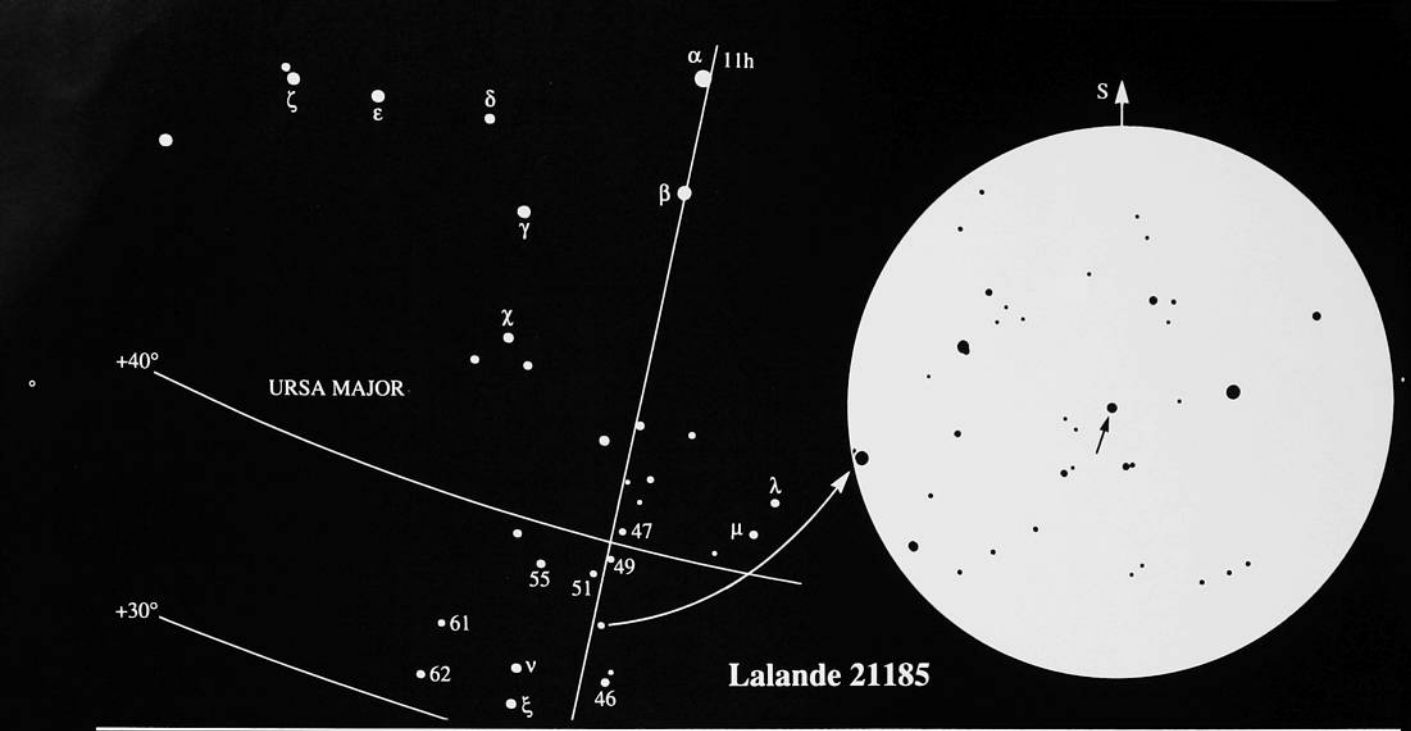
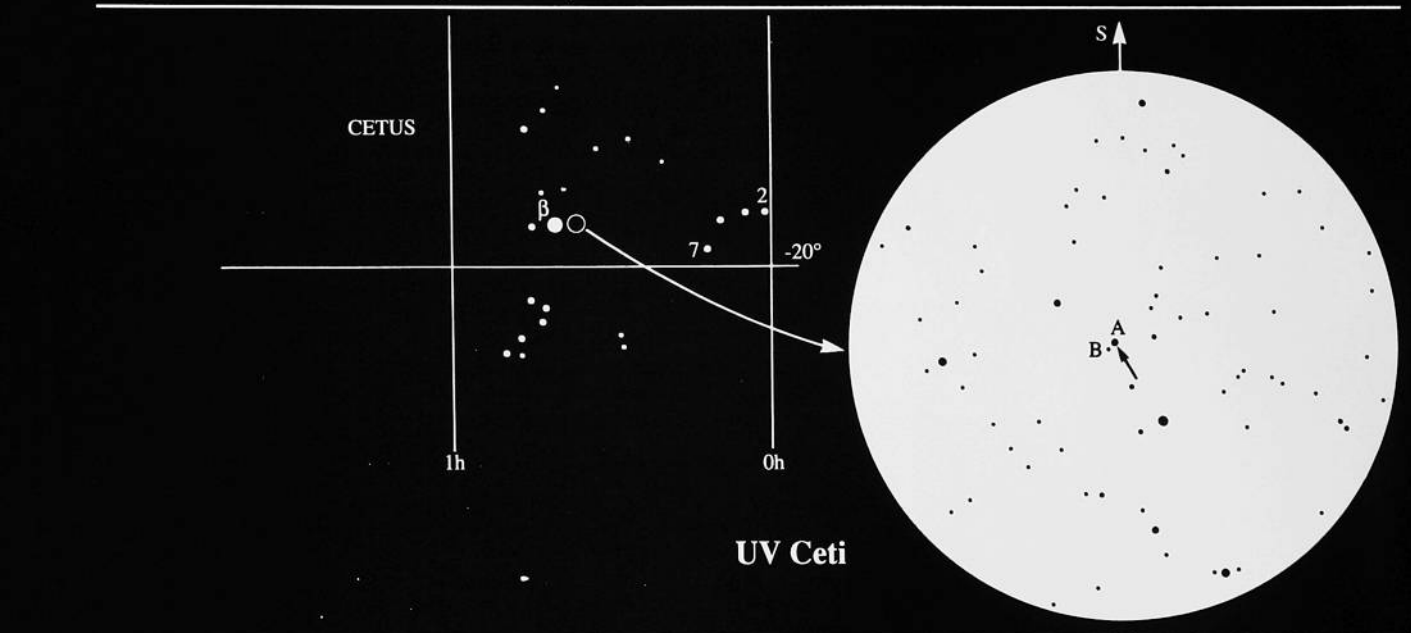


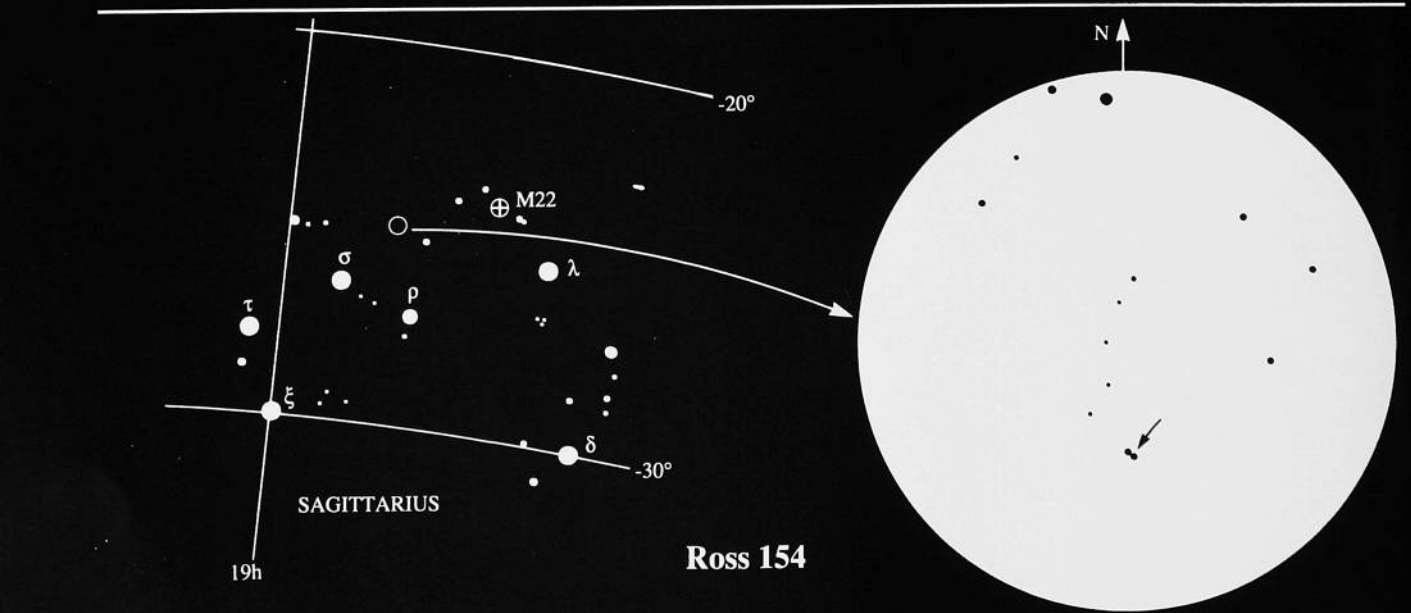
Wolf 359



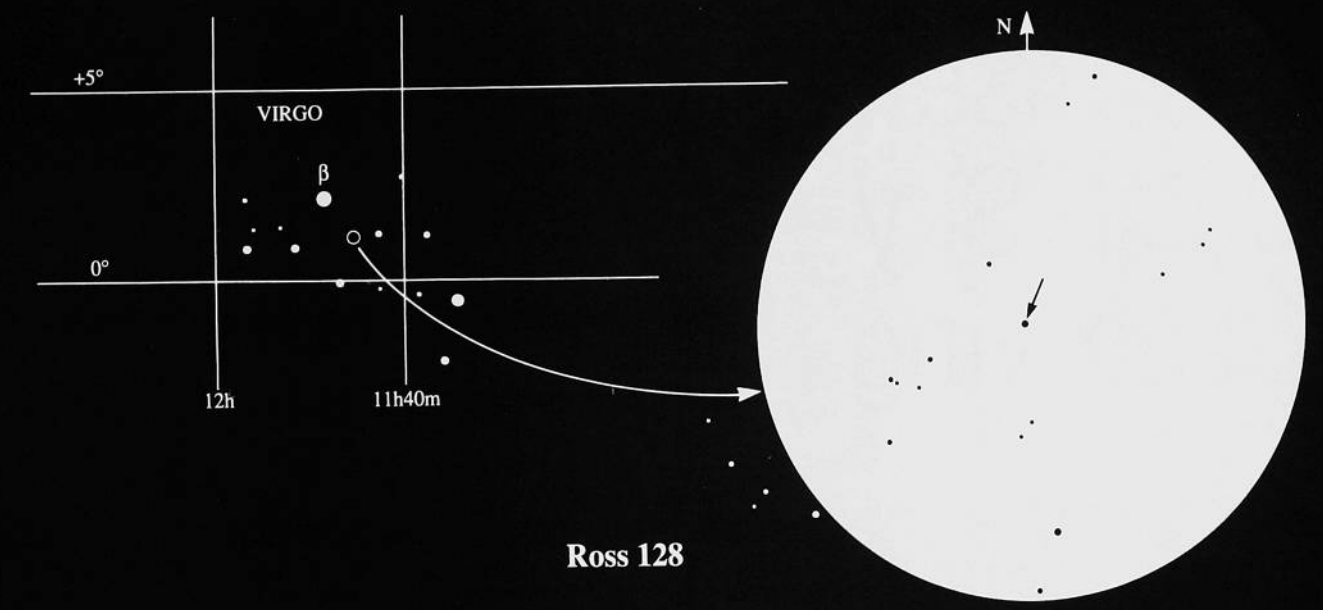
Lalande 21185



UV Ceti



Ross 154



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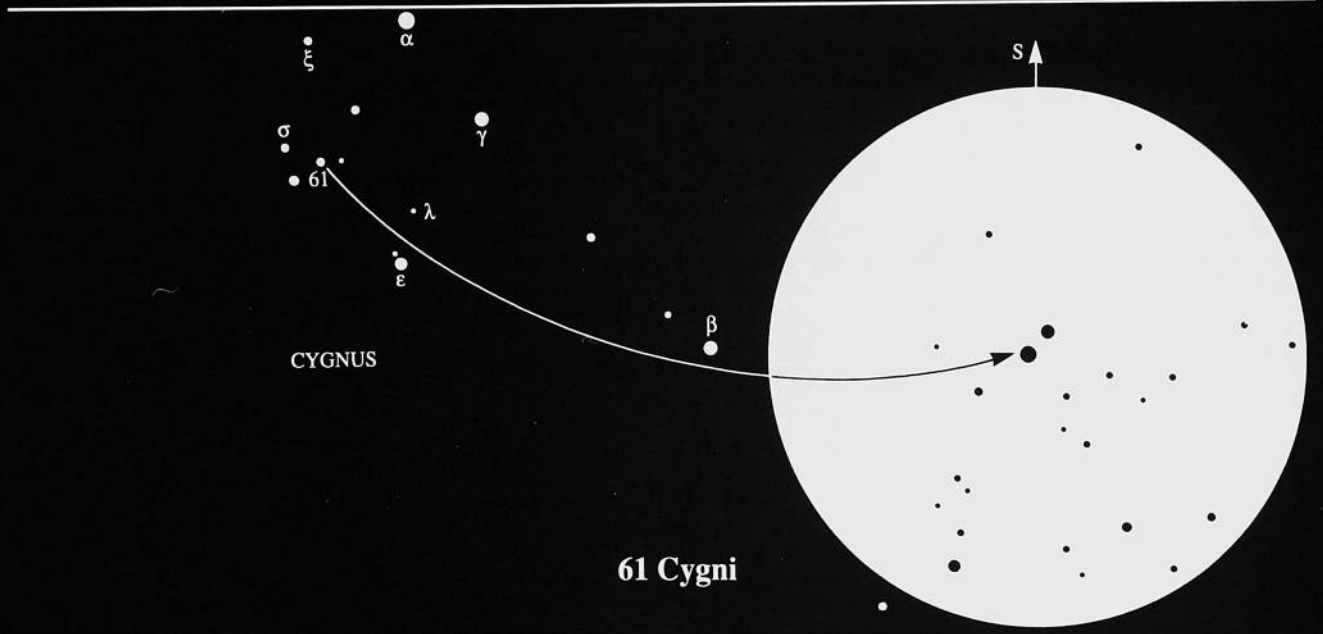
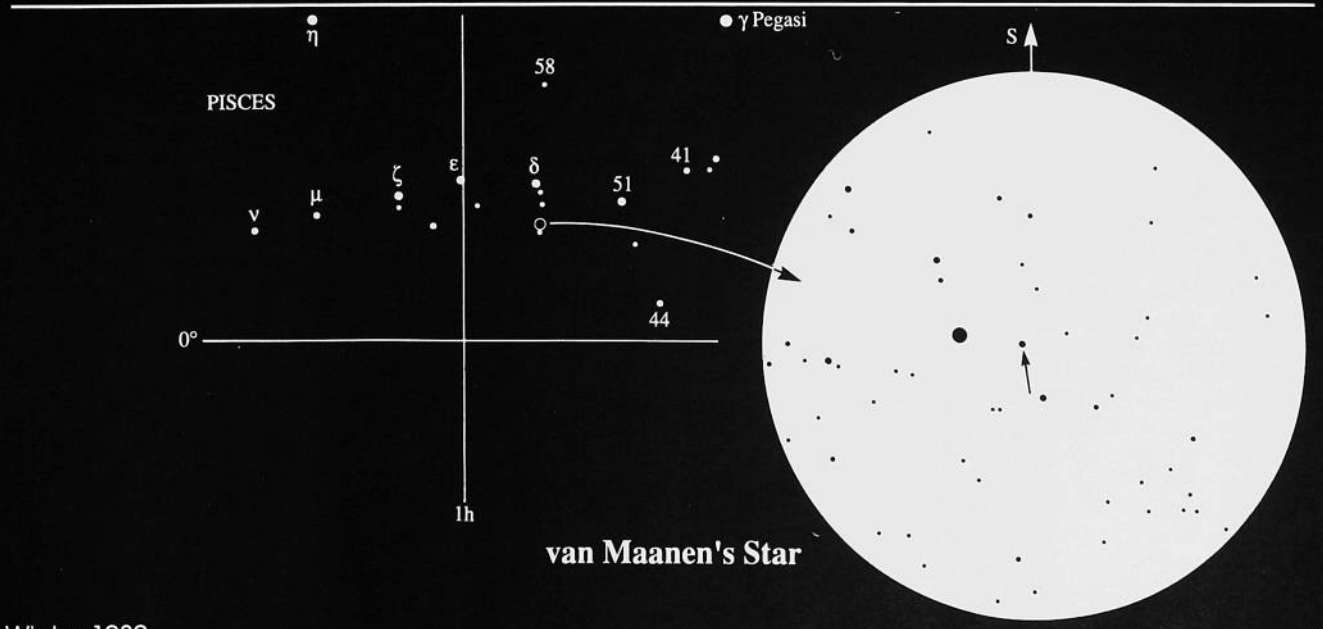


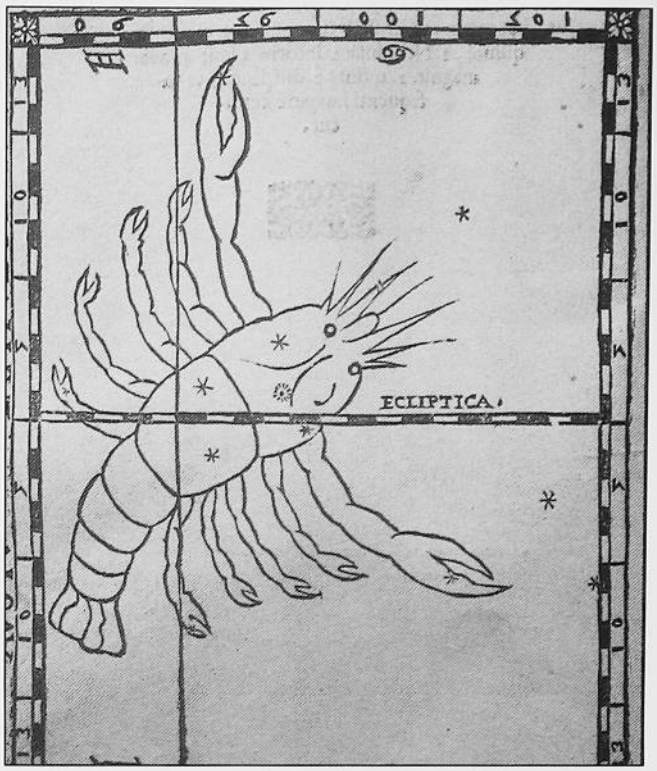
61 Cygni



van Maanen's Star

The Rise of Deep-Sky Observing

by Ray Harris



The Beehive Cluster was depicted as early as 1588 on Giovanni Gallucci's Theatrum Mundi. *Opposite page: Galaxies in the Virgo Cluster were represented as stars with a line drawn underneath on Lalande and Mechain's atlas of 1795.*

Today's amateur astronomer in search of deep-sky objects is truly fortunate. In addition to excellent optics, several accurate and detailed atlases are available to guide us on our searches of the sky. Works such as *Sky Atlas 2000.0* and *Uranometria 2000.0* provide a wealth of information about thousands of nonstellar objects. But it hasn't always been this way. Before these objects could be displayed on sky charts, they had to be discovered.

Following the invention of the telescope in 1608, the discovery of deep-sky objects proceeded slowly. This was partly due to the instruments being used and partly due to the mind set of the astronomers of that period. The first telescopes were long focal length refractors with small apertures. With their narrow fields of view and poor light gathering abilities, these telescopes were much better suited for studying the Moon and planets than for discovering faint star clusters and nebulosities. Besides, astronomers at that time were mainly interested in studying solar system objects and in determining precise star positions.

As a result, astronomers had stumbled upon only about two dozen previously unknown deep-sky objects by 1740. As instruments improved and philosophies changed, more discoveries were made. By 1783 Charles Messier and others had raised the total to about 140. That year, William Herschel began his survey of the heavens specifically in search of deep-sky objects, eventually adding about 2,500 more.

Pre-Telescopic Nebulae

Before Galileo first turned his telescope toward the sky, only a handful of deep-sky objects were known. Ptolemy listed seven nebulae in the second century, although several of these — Omega Cygni, Nu Sagittarii, and Lambda/Phi Orionis — later turned out to be no more than chance associations of a few faint stars. These "false nebulae" appeared on many of the early atlases. The only real deep-sky objects on Ptolemy's list were the Double Cluster in Perseus, the Beehive Cluster in Cancer, the open cluster M7 in Scorpius, and the Coma Berenices star cluster. In the tenth century the Persian astronomer Al Sufi added the Andromeda Galaxy. However, this "cloudy star" was apparently unknown to Europeans until it was observed telescopically by Simon Mayer in 1612. The only other extragalactic objects known before this were the Magellanic Clouds.

The first flat celestial charts appeared in Europe early in the fifteenth century. However, it was not until 1515 that Albrecht Durer published the first charts with a coordinate system accurate enough to fix the positions of the stars. Durer's maps were planispheres, circular charts each showing half the heavens. No deep-sky objects were depicted on Durer's maps.

In 1588 Giovanni Gallucci published the first real celestial atlas. His *Theatrum Mundi* contained forty-eight maps of the Ptolemaic constellations. Gallucci used an accurate coordinate system and included all seven of Ptolemy's nebulae. M7, however, was misplotted to coincide with the nearby star G Scorpii. Like the other false nebulae, this one was also to appear on atlases and planispheres for many years afterward.

The next significant atlas was Johann Bayer's *Uranometria*, published in 1603. One notable feature of this work was that, unlike most of its predecessors, the constellations were drawn as they appeared from Earth's surface rather than in reverse as if viewing a celestial globe. This "correct" geocentric orientation greatly simplified comparing the charts to the night sky.

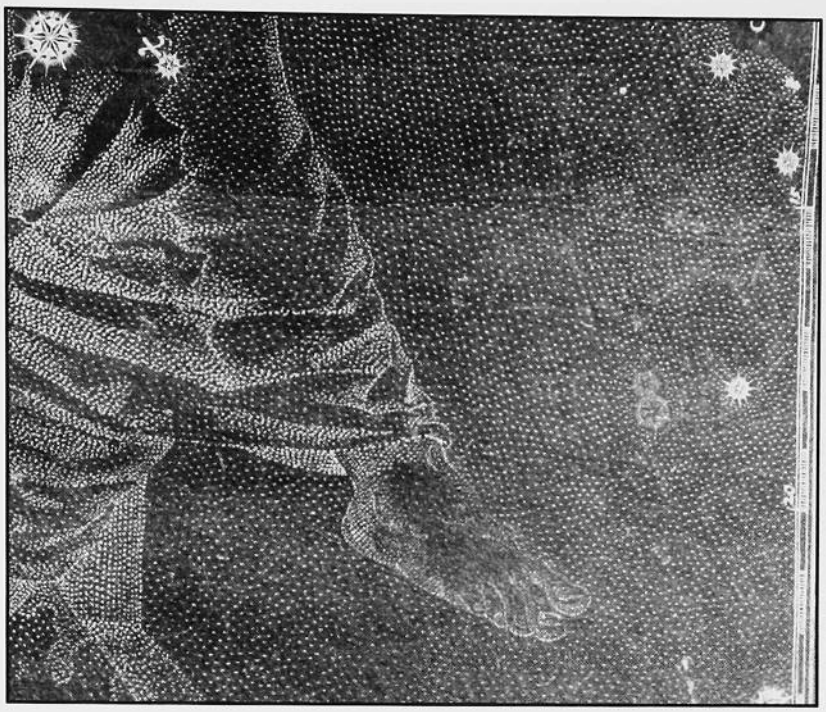
Bayer's forty-eight constellation charts included five of the seven Ptolemaic nebulae. The other two, Coma Berenices and Lambda/Phi Orionis, were shown as stars. M7 was again misplotted as G Scorpii. It is interesting to note that although the Double Cluster appeared as a pair of nebulae on Bayer's chart of Cassiopeia, it was depicted simply as two stars on his chart showing Perseus.

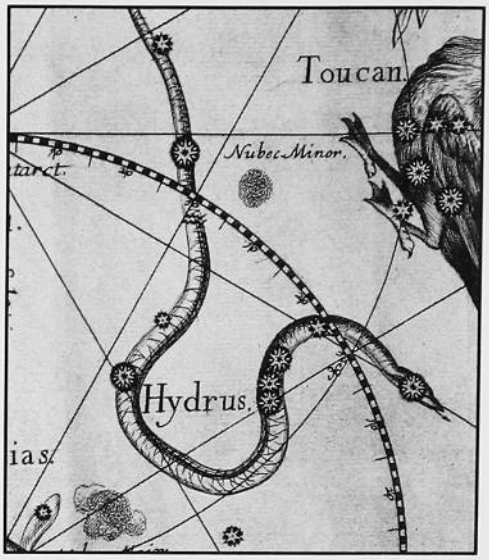
Bayer included an additional chart depicting twelve new southern constellations and the Magellanic Clouds, as charted by the Dutchman Pieter Keyzer. For northern star positions and magnitudes Bayer used Tycho Brahe's star catalogue, which had begun to circulate in 1598. Unfortunately, the catalogue identified several new stars in Capricornus and Hercules as being nebulous. These impostors and another east of Orion were faithfully depicted by Bayer and others over the next century and a half. In fact, false nebulae greatly outnumbered true deep-sky objects in *Uranometria*.

Schiller's Christian Sky

Julius Schiller's *Coelum Stellatum Christianum* was introduced in 1627. This beautiful work, containing forty-nine constellation charts, was arguably superior to Bayer's *Uranometria*. However, Schiller replaced nearly all the existing "pagan" constellations with new Christian figures and reverted to the more awkward backward view of the heavens. The new and unfamiliar constellations were not popular, and the atlas never achieved wide acceptance.

Schiller's *Coelum Stellatum* depicted many of the same deep-sky objects and false nebulae as Bayer's *Uranometria*. However, one new object was noteworthy: The Andromeda Galaxy, rediscovered by Simon Mayer in 1612, made its first appearance on a European work. The galaxy was depicted as nebulous on all major atlases





Left: The Double Cluster literally sat above the left foot of Cassiopeia in Bayer's Uranometria, *published in 1603. Above: In 1687 Hevelius depicted the Magellanic Clouds as nebulous objects on his* Firmamentum Sobiescianum.

that followed. Ironically, the reappearance of M31 coincided with the disappearance of the Double Cluster. Schiller's *Coelum Stellatum* was the last significant work to show the Double Cluster as nebulous until Bode's *Uranographia* of 1801, 174 years later. Even Charles Messier apparently ignored this naked-eye object, failing to include it in his famous list, even though he did include the Pleiades and the Beehive Cluster.

The next popular astronomical atlas appeared in 1660 when Andreas Cellarius published his *Harmonia Macrocosmica*. This vibrantly colored and artistic volume broadly addressed contemporary astronomical knowledge, including the competing solar system models of Ptolemy, Copernicus, and Tycho Brahe. Its colorful star charts were simple planispheres, one pair showing Schiller's Christian sky and others showing the classical constellations. No new nebulae appeared. Cellarius' atlas was well received; but with its small scale and very busy design, it could not have been very useful to serious observers of the day.

Hevelius and the Southern Sky

Johann Hevelius' *Firmamentum Sobiescianum* was published posthumously in 1690. *Firmamentum* contained fifty-four constellation charts and was notable for its improved mapping of the southern sky based on Edmond Halley's observations of 1676-77. For the northern sky Hevelius relied on his own highly accurate naked-eye observations rather than those of Tycho Brahe. Despite his spectacular telescopic studies of the Moon, Hevelius mistrusted telescopic sights for determining precise stellar positions.

Firmamentum displayed several deep-sky objects. In addition to M31, the Beehive Cluster, and the Magellanic Clouds, M7 was finally returned to its proper position. Two new objects recorded by Halley were also charted: Omega Centauri and an open cluster in the tail of Scorpius, NGC 6231. Along with increasing the number of deep-sky objects depicted, Hevelius succeeded in eliminating most of the false nebulae charted by his predecessors. Only three in the head of Capricornus and one in Hercules remained.

Flamsteed's Equatorial Coordinates

The first atlas to make a concerted use of telescopic observations of star positions was John Flamsteed's *Atlas Coelestis*. It was published in 1729, ten years after Flamsteed's death. Flamsteed began working on the atlas more than twenty-five years earlier but was reluctant to allow his catalogue or atlas to be published until he was satisfied that they were totally correct. Isaac Newton tried to expedite the publication of the catalogue but was unsuccessful. Edmond Halley finally succeeded in 1712, publishing the catalogue without the author's permission. With Halley's help John Senex produced a pair of planispheres in 1721 that were based on Flamsteed's observations. In addition to M31 and Omega Centauri, several new nebulae appeared: the globular cluster M13 in Hercules (discovered by Halley in 1714), the nebula M42 in Orion, the open cluster M11 in Scutum, and M8 in Sagittarius. Unfortunately, these did not appear on Flamsteed's spectacular atlas.

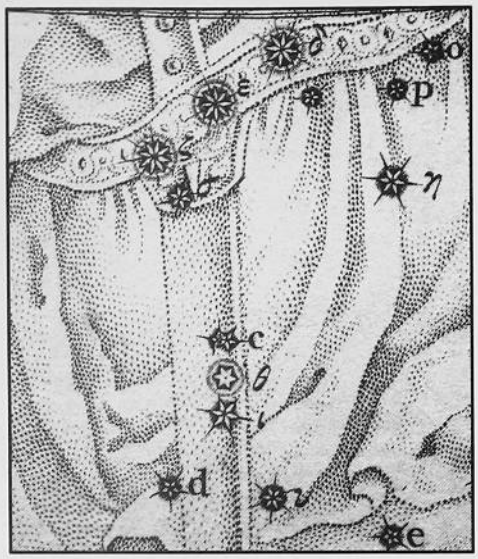
Atlas Coelestis contained only twenty-five charts covering the constellations that Flamsteed could observe from the Royal Observatory in Greenwich. With the exception of M31 in Andromeda, no other nebulous objects were depicted. The Beehive Cluster appeared as individual stars rather than as a nebula. Of course, the Pleiades also appeared as individual stars, but they had been routinely shown this way on earlier charts and atlases.

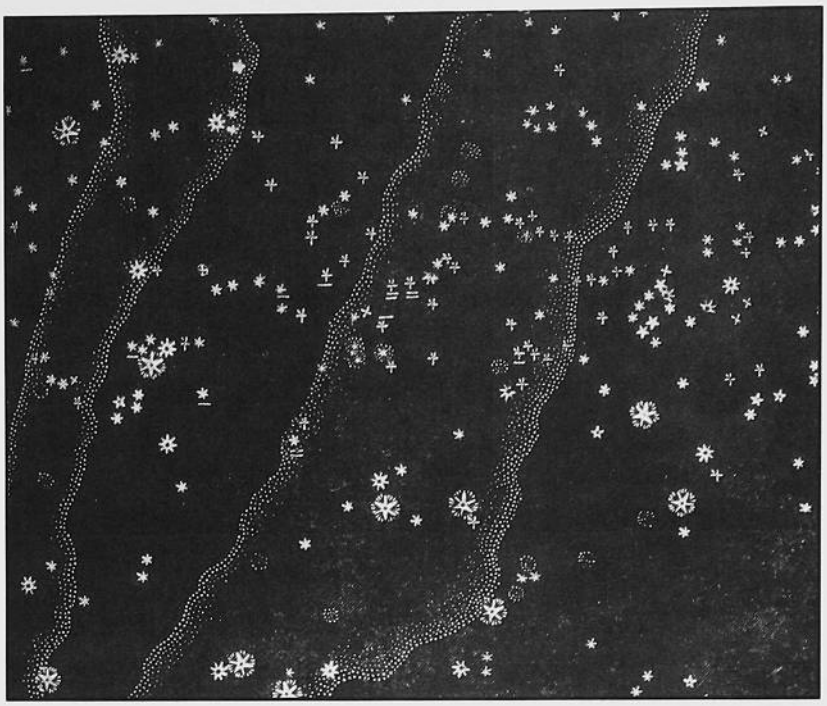
What made Flamsteed's work such an improvement over its predecessors was his use of an equatorial coordinate system. He portrayed the stars geocentrically and introduced a detailed equatorial grid using right ascension and declination. Previous atlases had all used celestial latitude and longitude based on the ecliptic. With its large format, accurate star positions, and convenient equatorial coordinates, *Atlas Coelestis* was to become the atlas of choice for many years. Although it was basically devoid of deep-sky objects, we shall see that it was used as the basis for the first true deep-sky atlas.

Doppelmayr and Bevis

Johann Doppelmayr's *Atlas Coelestis* was the next popular atlas to appear. Although Doppelmayr's charts were probably completed about 1720, his atlas was not published until 1742. This work was somewhat similar in concept to the one published by Cellarius in 1660. Most of its colorful plates were dedicated to solar system phemomena, and the entire heavens appeared on six charts. Stellar positions and magnitudes were not particularly accurate. The constellation figures were similar to those in Hevelius' *Firmamentum*, and the exact same deep-sky objects and false nebulae were shown.

It is worth noting the way in which the star Mira appeared in *Atlas Coelestis*. This star had been recognized as variable more than a century earlier, but most atlases and planispheres simply labeled it as a nova, if they called attention to it at all.





Right: Christian Goldbach created the most wonderful early draft of the Southern Milky Way for his atlas published in 1799. Above: The sword of Orion marks the spot of the Orion Nebula on a chart made by John Bevis in 1750.

On one of Doppelmayr's charts, Mira was depicted as a star within a star. It would seem logical to assume that this was an attempt by Doppelmayr to portray Mira's variable nature, except that another star, the nonvariable Gamma Canis Majoris, was portrayed this way, too.

About 1750 John Bevis prepared an interesting atlas he called *Uranographia*. Unfortunately, it was never published, although Charles Messier is known to have obtained a copy and highly prized it. *Uranographia* contained forty-nine constellation charts very similar in appearance to those in Bayer's *Uranometria* of 1603. The Beehive Cluster appeared as a small group of individual stars, and several other deep-sky objects, including three new ones, were depicted using a variety of nonstellar shapes. Unfortunately, the shapes of the symbols had nothing to do with the nature of the objects. A shaded ball was used for M31 (a galaxy), M13 and M22 (globular clusters), M35 (an open cluster), and M1 (a supernova remnant). A unique symbol with dots was used for M11. A third symbol, an open six-pointed star inside a circle, was used to represent M42, NGC 6231, Omega Centauri, and a number of false nebulae copied directly from Bayer's *Uranometria*. The open cluster M7 was conspicuously absent; it was depicted simply as a single star without nebulosity.

Flamsteed Revisited

As mentioned earlier, Flamsteed's atlas with its equatorial coordinates became the working atlas of eighteenth-century astronomers. It was republished in its original 20-inch by 24-inch chart size several times. However, the smaller French editions would have been of interest to deep-sky enthusiasts. Flamsteed's atlas was issued in a convenient 6-inch by 8-inch format by J. Fortin in 1776. Like Flamsteed's original, the far southern constellations were absent. This "second edition" included a number of deep-sky objects, many appearing for the first time: M7, M9, M10, M11, M12, M13, M15, M22, M27, M28, M31, M32, M42, M55, and NGC 6242.

While this represented an impressive improvement over previously published works, it was the French "third edition" by Joseph Lalande and Pierre Mechain that could rightfully claim to be the first true deep-sky atlas. Published in 1795, only fourteen years after Messier's famous list, this edition was basically identical to Fortin's edition except for the addition of numerous stars and nebulae. Lalande and Mechain depicted ninety-six objects as nebulous, including eighty-four Messier objects, three NGC objects, two IC objects, and seven false nebulae. Although only a few of the galaxies in Virgo were depicted as nebulae, several others appeared as stars with a single line under them. In addition, several other Messier objects, such as Praesepe, the Pleiades, M8, and M20, were depicted as stars. Mira, which was labeled "Variante" in Fortin's edition, was labeled "Changeante" in Lalande's and Mechain's edition.

Goldbach and Bode

Two final atlases are worthy of mention. Christian Goldbach published an atlas of fifty-six plates in 1799. This work displayed white stars against a black background. Each sky area was represented both with and without drawn constellation figures. The atlas included many of the Messier objects, but it was most notable for identifying numerous double stars. These were depicted as stars underscored with one or more lines.

The last of the great old-time celestial atlases, representing the peak of the craft, was Johann Bode's *Uranographia*, published in 1801. Its twenty large plates depicted more than 17,000 stars and hundreds of Messier and Herschel objects. In this atlas we finally see the return of the Double Cluster, which had not been depicted as nebulous since Schiller's atlas of 1627.

It took nearly two hundred years from Galileo's first telescopic view of the heavens until enough deep-sky objects were known that they could begin to feature prominently on the planispheres and atlases of the day. *Uranometria 2000.0* represents nearly two hundred additional years of cartographic evolution. Today, thankfully, most amateurs in search of deep-sky gems are limited more by their optics and by viewing conditions than by their atlases.

Ray Harris is a Senior Licensing Specialist with Pennsylvania Power and Light in Allentown, Pennsylvania. He is an active observer and astrophotographer and is currently Treasurer of the Lehigh Valley Amateur Astronomical Society.

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Deep Sky Reports

It'll be a Wet Time in the Old Town Tonight

by Robert Reeves

You don't have to be a meteorologist or a magician to know what the weather is going to be like at the Texas Star Party, held each spring in Fort Davis, Texas. Since its inception in 1982, the TSP has been clear and dry on even-numbered years, and rainy and wet on odd-numbered years. This year's gathering of a record 657 astronomers, held between May 31 and June 4, 1989, was wet.

As I left San Antonio under sunny skies bound for this year's TSP, I hoped this would be the year that would break the pattern. However, the closer the Davis Mountains of west Texas loomed over the horizon, the more apparent it became that tradition wasn't about to yield. Heavy rain and rapid-fire lightning greeted me as I approached Fort Davis. "It'll pass. After all, it's going to be a long week," I thought. "Even in wet years, we still have at least 50 percent clear skies."

When I got to the Prude Ranch the day before the Star Party began, my eyes fell on a marvelous sight: the largest gathering of amateur telescopes in the world. Judging by the large number of telescopes, it was easy to believe when someone later told me that this year TSP attendees temporarily doubled the population of Fort Davis.

On Tuesday, May 30, the star party did its best to begin in earnest. However, powerful thunderstorms along with an estimated 5,000 lightning bolts prevented most everything from happening. These lightning displays continued to plague observers until Friday night.

On Wednesday afternoon the TSP formally got under way. The traditional paper sessions in the afternoon, astronomical vendor displays, tours of nearby McDonald Observatory, and endless prowling among other people's telescopes helped to divert people's attention from the inclement weather. The general pattern was partly cloudy to cloudy in the morning and early afternoon and heavy clouds and rain squalls in the late afternoon and at night.

But we had the talks. Klaus Brasch, a well-known observer and astrophotographer from Tulsa, Oklahoma, began the program. Klaus presented his photo-visual studies of the 1988 Martian apparition, which featured the technique of drawing his visual eyepiece impressions of Mars directly on a photographic print taken at the same time. The resulting image had a startlingly similar appearance to the high-resolution digitized CCD images of Mars obtained by professionals.

Ron Dawes and Rick Frankenberger of San Antonio presented their techniques for organizing large expeditions for grazing lunar occultations and stellar occultations by asteroids. They also presented their methods for computerized data reduction of these group observations.

Brian Skiff, TSP's resident fixture from Lowell Observatory, started the first of several discussions at this year's star party about the science and

Attendees of the 1989 Texas Star Party pose as the state of Texas. Photo by Robert Reeves.

The Texas Star Party: A View from across the Big Pond by Steve Camplin

When I first heard about the Texas Star Party, I had no idea what to expect. Would it be a party with food, drink, and music? Inquiries soon gave the true picture. Just the thought of a week-long observing session under some of the darkest skies in North America made our British mouths water. For several months letters hurtled to and fro across the Atlantic. A group consisting of myself, Len Camplin, Anthony Emberson, Philip Benson, and Kate West made arrangements with the Houston Astronomical Society for accommodation and with our travel agent for transport. We flew into Houston Intercontinental on May 14th and were met by Steve Goldberg of the Houston group. After three days in Houston, during which time we were taken on a tour of NASA, shopped for souvenirs, and just generally had a good time, we made our way to Fort Davis and the TSP.

The Prude Ranch was just as I'd imagined it to be: rustic but comfortable (the swimming pool got a lot of use over the next few days). We'd heard several stories about the quality of the "Prude Food," but we were relieved to discover that they were unfounded. After settling into our cabin, Old Maid's Haven, we had a look around the ranch, checking out the few scopes that had already been set up in anticipation of the first night's observing. Steve Goldberg let us borrow his 5-inch Celestron scope, as I wanted to do some astrophotography.

However, we had no such luck. The next few nights gave us some spectacular and dramatic lightning storms that made an English thunderstorm look like a cheap firecracker. It was a little embarrassing the way nearly every one, once they discovered how far we had come, apologized for the weather. We ended up apologizing ourselves for apparently bringing the English weather over with us, just to make us feel at home.

During the few moments when it was clear, we had stunning views of deep-sky objects. I'll never forget my first view of Omega Centauri, which we never see from England, glowing like a cloud of fireflies. I managed to do what quite a few first-time attendees do and mistook the rising Milky Way for a storm cloud.

On one night our group went up to McDonald Observatory and spent some time with the 36-inch Cassegrain. We were lucky to get four hours of perfectly clear skies and were rewarded with some amazing views of objects that in a smaller scope would be seen as just small fuzzy patches. I also became a celebrity, even if only for a short while. A television crew came to the ranch to interview the organizers and heard that an English group came over for the party. I've not actually seen the broadcast, so it's possible the spot never got on the air, but my moment of fame was nice while it lasted.

All too soon it was the last day, but there were still one or two surprises to come. At the closing ceremony we were pleasantly surprised to be presented with the award for the longest distance traveled. A beautiful certificate now takes pride of place on my living room wall.

Overall, the 1989 TSP was everything I'd hoped for. We all made new friends, and the welcome that we received was incredible. It's one thing to read about American hospitality, but something else to actually experience it.

141 Wakering Road
Shoeburyness, Essex
England SS3 9TN

TEXAS
STAR
'89

Scenes like the one above typified nights at the TSP. Photo by Larry Mitchell. Opposite page: When stars were visible, people bolted to their telescopes. Photo by Robert Reeves.

medical aspects of dark adaptation. Brian presented some insights into the subject, but when it all boiled down to the basics, it is evident from his presentation that the feeblest, dimmest red light you can possibly get by with is what you should use. Even bright red light will ruin dark adaptation.

This year's TSP attracted a large number of commercial astronomical vendors. The usual folks were there, including the ever-friendly Biff Bigbie from Astro-Tech, representatives from Lumicon, Tuthill, Jim's Mobile, and other familiar companies. New at the TSP this year was a large and well-attended display from Parks Optical, and a wide collection of items from the National Optical Astronomy Observatories gift shop.

While strolling past the vendors, attendees could visit the *GOES* weather satellite picture receiving station set up at the vendors' hall. Many long and gloomy faces hovered about the *GOES* picture as it became apparent that more thunderstorms were coming to the Prude Ranch. Although the TSP was surrounded by intense lightning, there was no damage done because the closest bolts cleared the observing areas by 600 meters.

The weather improved somewhat midway through the TSP and allowed solar observing through broken clouds. The solar activity that began earlier this year was in full speed. One particular prominence remains imbedded in my memory: It ballooned out so far from the edge of the Sun that it looked like an oak tree attached to the solar surface by its roots.

Talks on Thursday covered a wide range of topics. The largest telescope ever set up at the Texas Star Party was the 32-inch reflector built by a Houston group led by Al Kelly. Needless to say, his presentation on how the instrument was built drew an attentive audience. Although the mirror took over a year to make, the telescope itself was started in April 1989 and completed just hours before transport to the Prude Ranch. As expected, the few views we had through the 32-inch scope after the weather cleared were superb!

Joel Harris of Twilight Tours explained the prospects for observing the 1991 solar eclipse from Baja California. His assessment of the upcoming spectacle? If you haven't yet made reservations to be there, you are probably out of luck. Virtually everything is completely booked up.

"A New Look at Pluto" was the subject of the Thursday evening guest speaker, Richard Binzel from the Massachusetts Institute of Technology. This presentation contrasted well with the talk given two years ago by Clyde Tombaugh, which recalled his discovery of the planet. Together, the talks gave interesting portrayals of the old and new Pluto.

Twilight clearing on Thursday provided the first real observing at this year's TSP. The usual delights of Omega Centauri and galaxy hopping slaked everyone's observational thirst, but clouds returned about 2:00 a.m. and cut off prime Milky Way observing. That evening did not disappoint anxious observers as the skies again cleared at sunset and provided four good hours of observing before clouds stopped the rise of the Milky Way. In addition to deep-sky observing, a parade of planets attracted eyepiece interest. The usually ignored Neptune and Pluto were much-sought-after objects. At the TSP this year, Pluto was an easy object to see in a 10-inch reflector.

On Saturday morning bright sunshine greeted everyone at dawn as the clouds passed and the typical hot Texas Sun began beating down on the TSP. The day's activities included the astrophoto contest, with an amazing seventy-two entries, the group photo, and a large swap meet. This year's swap meet provided the astronomical tinkerer with all sorts of items to choose from, ranging from books to large refractors. One item that caught my attention was a black T-shirt that read: "DATE AN ASTRONOMER. HE IS THE ONLY ONE WHO CAN PROMISE YOU THE SUN, MOON AND STARS, AND *DELIVER*!"

Saturday evening approached with thick cloud cover promising everybody a long night's sleep for the drive back home the next day. As the auditorium filled to capacity to hear the Saturday evening keynote speaker, no one thought about observing, and the evening's events proceeded at a leisurely pace.

Don Parker of Miami, Florida, delivered a masterful discussion on his planetary observing and photography to a "deep-sky audience." With a skilled blend of science and humor, Don fascinated the hundreds present with his amazingly detailed planetary photos and tips on his photographic techniques.

The conclusion of the Texas Star Party arrived with the traditional awards and door prizes. As usual, there were so many give aways that it was nearly impossible for you or one of your friends to leave empty handed.

However, the best part of the evening was yet to come. As the ceremonies ended and everyone made their way back to bunks and camps, the sky began to clear. Within half an hour the sky cleared. Plans for sleep were abandoned and scope covers were removed for one last shot at the darkest skies in North America. Die-hard observers were not disappointed as the skies remained clear and dry until dawn.

Although this year's proceedings got off to a soggy start, the 1989 Texas Star Party still managed to log 50 percent of the nights between Wednesday through Saturday clear. The weather didn't cooperate fully this year, but if tradition holds it's almost certain to be clear the entire week next year.

520 Rittiman Road
San Antonio, TX 78209

Deep Sky Reports
Observing at High Magnification
by Michael Sweetman

That people are creatures of habit can be a strength or a weakness. One of the habits of today's amateurs is to rely on new equipment to increase observational enjoyment. We too easily pass over new techniques for observing, but hurriedly rush out orders for new eyepieces and filters. This is primarily true when it comes to ideas that go against conventional thinking.

One outstanding case in point is the use of high magnifications for observing deep-sky objects. I first appreciated the importance of this in an article by Roger N. Clark called "The Secrets of Deep-Sky Observing" in *Sky and Telescope*, September 1985.

Clark explained why high powers are so useful for deep-sky observing. First, the eye can resolve detail finer than 1' in bright light but can't make out features smaller than 20' or 30' across when the illumination is about as dim as the dark sky background in a telescope. By using high magnification, you allow your eye to see details that were too small at low power.

The idea that short focal length scopes at low power should be used exclusively for deep-sky observing is false. Over the last few years I've been using a 10.25-inch f/16 Cassegrain telescope. I use this instrument primarily for planetary work but now find it a great supplement for deep-sky viewing. My first experience came when I turned the scope on M20 after observing Saturn. My lowest magnification is 130x and I expected to observe nothing of this low surface brightness object.

I was stunned. Though still low in surface brightness, the image showed many details I had never observed before. I noted an increase in contrast in the nebula's outer areas. Another memorable observation was M32. I have observed this object many times and at best saw it as a hazy patch with a grainy surface. One night I looked at M32 at 462x and saw it as a shimmering blanket of minute, starlike speckles.

A view of the Ring Nebula in Lyra with Sweetman's 10.25-inch f/16 Cassegrain at 347x shows subtle variations in the surface brightness of the Ring. All sketches in this article are by Michael Sweetman using his 10.25-inch Cassegrain.

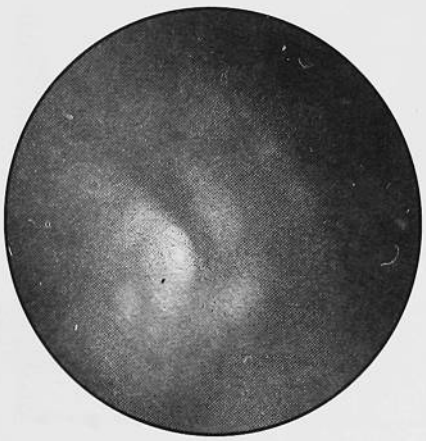
The unusual reflection M78 becomes an object with a multilayered surface brightness structure at 130x. Such fine detail remains invisible at lower powers.

I also use high powers with my 6-inch f/5 reflector. My visual descriptions now include upper-limit magnifications that are useful in observing details. Comparing my observations with those published in a variety of catalogs reveals a gross underuse of magnification by those who contributed observations. Many of my descriptions reveal more details than those made with comparable or even larger apertures.

Don't be afraid to use high powers when observing deep-sky objects. Test your instrument's capabilities the next time the seeing is good, and you'll be surprised at the level of detail you can see.

2961 West Katapa Trail
Tucson, AZ 85741

Above: The full glory of M20, the Trifid Nebula in Sagittarius, comes shining through at 130x. Such a view shows off tremendous detail in the nebulosity that spans a wide range of contrast. Right: A view of the nucleus of the Andromeda Galaxy at 694x reveals a tight, bright nucleus surrounded by nebulosity of varying surface brightness. Far right: A similar view of the nucleus of galaxy M33 at 520x shows knots, clumps, and irregular structures not visible at even moderately high powers.



Deep Sky Reports

Developing a Deep-Sky Observing Form

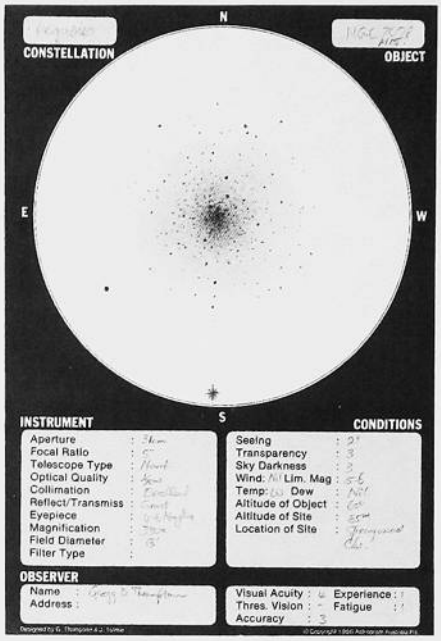
by Gregg D. Thompson

When I was a young boy, I got my first telescope, a 30x60 terrestrial instrument. With great anticipation I turned it on the Moon and was enthralled to see far more than I had ever expected. There before my eyes was the reality of another world. I could witness the stark illumination of the Moon's mountain ranges, crevasses, plains, and craters. I could watch the lunar terminator progress hour by hour and observe Jupiter's mini solar system in action. Surely Saturn's rings were not real! To this ten year old it was like science fiction come true.

I soon turned my spotting telescope on a multitude of stars, and then those curious bright spots in the Milky Way to see what I might discover. Much to my amazement I found strange cometlike objects and star clusters abounded. I became hooked on searching the depths of the universe to see what else I could find.

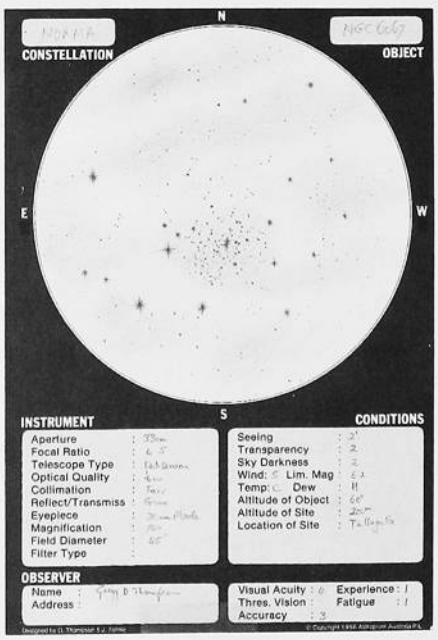
I had developed an unquenchable thirst for trying to see every object mentioned in books like the *Larousse Encyclopedia of Astronomy* and Barnard, Bennet and Rice's *Celestial Handbook of the Heavens*. My naivety then in not appreciating the difficult nature of some of my targets, combined with my determination to even glimpse some of these remote objects, forced me to acquire, by trial and error, observational skills that I would always use.

Like most observers, I started making verbal descriptions of the objects I observed, but the descriptions frequently became too long and tedious to make when I tried to record all I could see. It became apparent that the most practical way to record an observation was to sketch the object as accurately as possible and support the drawing with some descriptive notes detailing aspects of the object that were not apparent from the drawing. These additional details included colors, appearance in the view finder and at other magnifications, and other such factors.



On many occasions I looked at observations made of the same objects and tried to compare them, but this was always difficult because I had not recorded the observing conditions or enough about the different telescopes I had used. I saw drawings made by other observers published in books and magazines that typically had only the aperture and magnification given.

I began to wonder how other observers' visual acuity and threshold vision compared to mine. Was the observer attempting to make an accurate illustration or a rough sketch? How good was the seeing, sky darkness, and transparency when their observations were made? Did wind or cold affect the quality of their observations? What type of eyepiece was used? Was the telescope well collimated? Did the mirror have a good figure? Did the observer use a filter? What was the field diameter and orientation of the field? Without knowledge of these factors, it is difficult to relate observations made by different observers using different telescopes under various observing conditions.



It became obvious that an observation form needed to be designed that could record all the variable factors that influence an observation. I set about the task. The observation form I produced is the result of that endeavor and a consensus of opinions solicited from many experienced deep-sky observers with similar interests.

To the beginner, the form may appear to have many variables to quantify and a couple that may at first appear difficult to determine. However, observers need only complete as many details of the form as they wish. The more observing one does, the more one understands the importance of each section and can add as much information as possible.

Many of the sections are not likely to vary for any one observer if the same telescope and observing site is used, so these sections are standard. The other portions take only a couple of minutes per observation to complete, especially if simple abbreviations are used.

Making drawings of deep-sky objects forces one to learn how to record carefully details of proportions and brightness variations and to make the maximum use of their eyesight, telescope, and conditions. There's no more important lesson to learn if you aspire to be an experienced observer of the sky.

Springwood Observatory
7 Strover Court
Springwood
Queensland, Australia 4127

ORION

CONSTELLATION

NGC 1976 inner region M42

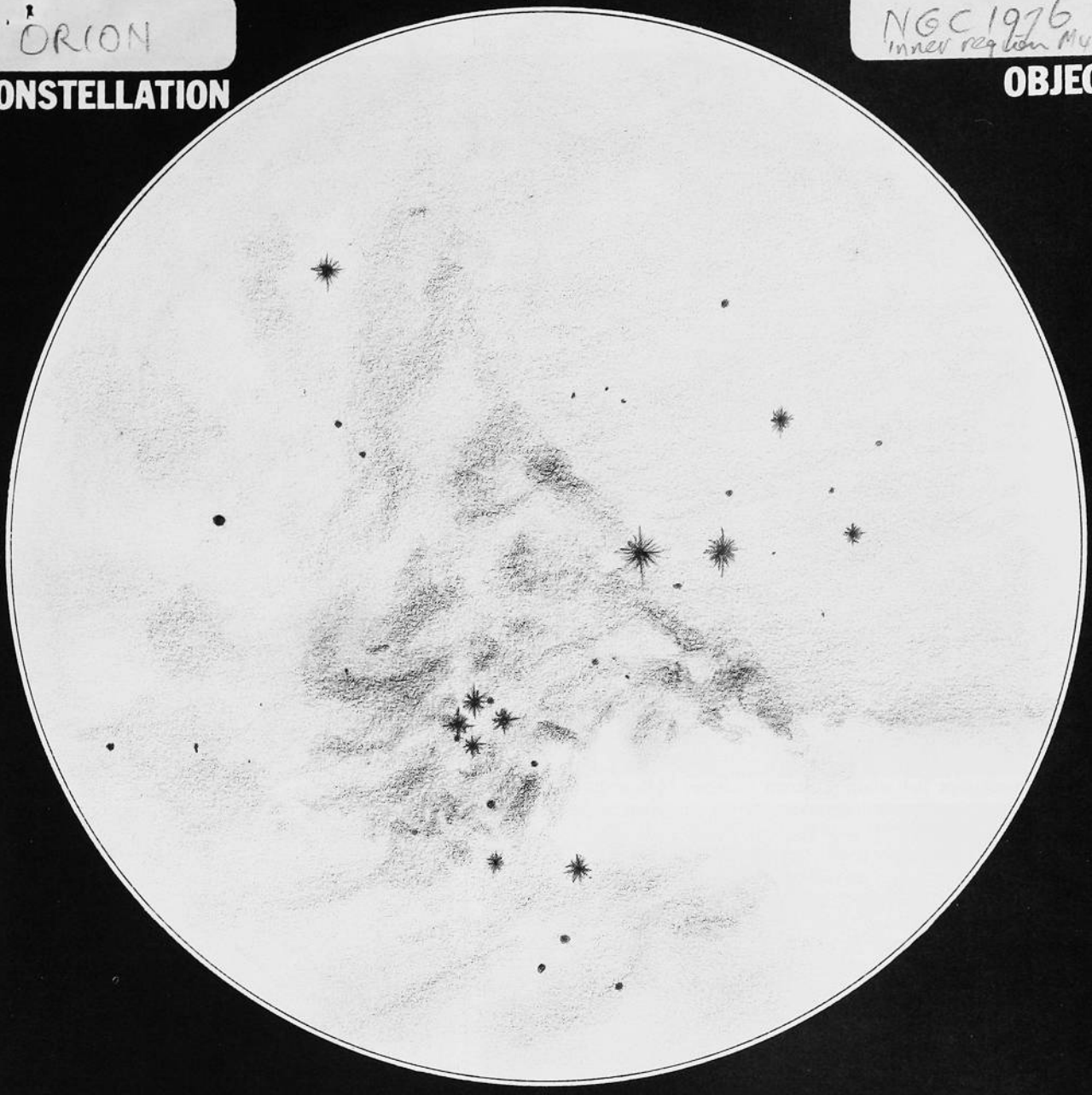
OBJECT

N

E

W

S



INSTRUMENT

Aperture	:	31 cm
Focal Ratio	:	5
Telescope Type	:	Newt
Optical Quality	:	1/20w
Collimation	:	Excell
Reflect/Transmiss	:	Good
Eyepiece	:	4.8 Vaglen
Magnification	:	330x
Field Diameter	:	13'
Filter Type	:	

CONDITIONS

Seeing	:	2"
Transparency	:	1
Sky Darkness	:	2
Wind: Nil Lim. Mag	:	5.7
Temp: Warm Dew	:	Nil
Altitude of Object	:	75°
Altitude of Site	:	85m
Location of Site	:	Springwood Observatory

OBSERVER

Name	:	Gregg D. Thompson
Address	:	

Visual Acuity	:	6	Experience : 1
Thres. Vision	:	_	Fatigue : 1
Accuracy	:	1	

Deep Sky Reports

Two for the Price of One: Pairs of Deep-Sky Objects

by T. C. Hoffelder

With the exception of some rich fields of galaxies, finding a region with more than one impressive deep-sky object in a single field is a rarity. It is even less likely that two objects visible together will be unrelated — that is, very close to each other yet lying at different distances from Earth. I call these pairs of objects Unrelated Double Objects (UDOs) and have compiled a listing of forty such pairs visible in small- and medium-sized telescopes.

These objects can be divided into two categories. One contains different object types, such as a planetary nebula and a galaxy, as in the case of M97 and M108 (UDO 21). The other category contains objects of the same type but wildly different appearances, such as open clusters M35 and NGC 2158 (UDO 14). Combinations of open clusters and emission nebulae and of multiple galaxies are not considered to be UDOs because they are usually related when visible in the same field.

UDO 14 is a fine example of a double object with similar components. The striking difference in appearance between M35, a large open cluster holding more than one hundred stars, and NGC 2158, which shows up nearby as an unresolved blur, can be appreciated in any scope at low power. Simultaneous viewing of these two objects readily demonstrates what a difference of 4 kiloparsecs can do for the appearance of an open cluster.

The most interesting UDOs, however, are those comprised of different object types. For example, the Hercules Cluster (M13) is a familiar sight to all deep-sky observers. But how many observersnotice the 11th-magnitude galaxy, NGC 6207, half a degree to the northeast? Because this little Sc-type spiral is elongated toward the globular, the view of UDO 12 is reminiscent of photos showing the nucleus and jet of M87. Adding to the appeal of UDO 23 is the fact that the light from the galaxy has traveled 1,500 times farther than the light from the cluster.

Another intriguing pair is NGC 6939 and NGC 6946 (UDO 36). Both objects appear to be 8'-diameter patches of light glowing at about 10th magnitude, but that is the only thing these two objects have in common. NGC 6939 is an open cluster containing about a hundred stars lying five kiloparsecs away, while NGC 6946 is an Sc-type galaxy containing billions of stars and lying at a distance of 4 megaparsecs.

UDO 17 is probably the most well-known pair of nonrelated objects. It consists of the open cluster M46 and NGC 2438, a planetary nebula superposed on the northern edge of the cluster's center. With 150 stars between magnitudes 10 and 13, M46 is a beautiful sight by itself. The addition of the 11th-magnitude planetary, a ghostly version of the Ring Nebula in Lyra, makes the view more interesting than nearly any other deep-sky duo.

The list of UDOs includes the brightest examples of those separated by a maximum of one degree. The descriptive information is from Becvar's *Atlas of the Heavens*; coordinates from the same source were used to calculate the right-angle sweeps. The sweep coordinates are provided for those who use this system or for those who would like to try a simple but accurate location method that does not require setting circles or detailed charts. The sweep coordinates listed for the second object of each pair are from the center of the first object.

A quick review of the UDO listing reveals that more than half of the pairs are made up of open clusters. One of them, number 40, even contains three clusters. This result can be expected because open clusters are concentrated along the Milky Way and are second in abundance only to galaxies. It is also no surprise that only five UDOs include a galaxy as one component because few can be seen along the Milky Way, where the clusters and nebulae congregate.

Double Systems for Common Telescopes

Object	R.A.(1950)	Dec.	Type	Mag.	Size	Dec. Sweep	R.A. Sweep	Sweep Star
103	00h22.6m	61°03'	oc	10.8	13'	2.2° N	2.0° E	β Cas
136	00h28.7m	61°15'	oc	11.3	2'	0.2 N	0.7 E	
146	00h30.3m	63°01'	oc	9.8	6'	2.6 N	2.6 W	γ Cas
133	00h28.4m	63°04'	oc	9.1	7'	—	0.2 W	
246	00h44.6m	-12°09'	pn	8.5	4'x3'	1.7 S	5.2 W	η Cet
255	00h45.2m	-11°45'	gal	12.4	3'x2'	0.4 N	0.2 E	
381	01h05.2m	61°16'	oc	9.2	8'	8 N	1.4 E	γ Cas
358	01h02.0m	61°46'	oc		3'	0.5 N	0.4 W	
457	01h15.9m	58°04'	oc	7.5	10'	1.9 S	0.9 W	δ Cas
436	01h12.4m	58°33'	oc	8.8	4'	0.5 N	0.4 W	
M103	01h29.9m	60°27'	oc	7.4	5'	0.5 N	0.9 E	δ Cas
Tr.1	01h32.3m	61°02'	oc	4		0.6 N	0.3 E	
637	01h38.3m	63°47'	oc	7.1	3'	0.4 N	1.4 W	ε Cas
609	01h33.7m	64°18'	oc		3'	0.5 N	0.5 W	
663	01h42.6m	61°01'	oc	7.1	11'	2.4 S	1.0 W	ε Cas
659	01h40.8m	60°28'	oc	9.8	5'	0.6 S	0.2 W	
11871	03h02.3m	60°29'	en		1'	4.8 N	1.9 E	ηCas
I 289	03h06.2m	61°08'	pn	12.3	30"	0.6 N	0.5 E	
1220	03h07.8m	53°10'	oc	11.8	1.5'	0.2 S	1.0 E	γ Per
Kg 5	03h11.0m	52°32'	oc	7		0.6 S	0.5 E	
1807	05h07.8m	16°28'	oc	7.8	10'	3.0 N	3.4 E	o Ori
1817	05h09.2m	16°38'	oc	7.9	15'	0.2 N	0.3 E	
M38	05h25.3m	35°48'	oc	7.4	20'	1.4 S	6.3 W	φ Aur
1907	05h24.7m	35°17'	oc	9.9	5'	0.5 S	0.1 W	
M35	06h05.7m	24°20'	oc	5.3	40'	1.8 N	1.4 W	η Gem
2158	06h04.3m	24°06'	oc	12.5	4'	0.2 S	0.3 W	
2158	06h04.3m	24°06'	oc	12.5	4'	—	—	—
I2157	06h01.8m	24°02'	oc	8.5	4'	0.1 S	0.6 W	
M47	07h34.3m	-14°22'	oc	4.5	25'	4.9 S	1.1 W	α Mon
2423	07h34.8m	-13°45'	oc	6.9	20'	0.6 N	0.1 E	
M46	07h39.6m	-14°42'	oc	6.0	24'	5.3 S	0.2 E	α Mon
2438	073b9.6m	-14°36'	pn	11.3	1'	—	0.1 N	
2453	07h45.7m	-27°07'	oc	9.4	5'	2.4 S	0.3 W	ξ Pup
2452	07h45.6m	-27°13'	pn	12.6	30"	0.1 S	—	
2571	08h16.9m	-29°35'	oc	7.5	8'	5.4 S	2.5 E	ρ Pup
2580	08h19.4m	-30°09'	oc	9.6	9'	0.6 S	0.6 E	
2580	08h19.4m	-30°09'	oc	9.6	9'	—	—	
2567	08h16.6m	-30°29'	oc	8.3	10'	0.3 S	0.6 W	
M108	11h08.7m	55°57'	gal	10.7	7'x1'	0.7 S	1.4 E	β UMa
M97	11h12.0m	55°18'	pn	12.0	2'	0.6 S	0.5 E	
M53	13h10.5m	18°26'	gc	7.6	3'	0.6 N	0.7 E	α Com
5053	13h13.9m	17°57'	gc	10.5	3'	0.5 S	0.8 E	
M13	16h39.9m	36°33'	gc	5.7	10'	2.5 S	0.3 W	η Her
6207	16h41.3m	36°56'	gal	11.3	2'x1'	0.4 N	0.3E	
6440	17h45.9m	-20°21'	gc	0.4	30"	0.7 N	5.8 W	μ Sgr
6445	17h46.3m	-20°00'	pn	13.2	30"	0.4 N	0.1 E	
M7	17h50.7m	-34°48'	oc	3.2	60'	2.2 N	0.9 E	G Sco
6453	17h48.0m	-34°37'	gc	11.2	30"	0.2 N	0.6 W	
M7	17h50.7m	-34°48'	oc	3.2	60'	—	—	
H18	17h53.0m	-35°17'	oc	8.8	15'	0.5 S	0.5 E	
M21	18h01.8m	-22°30'	oc	6.5	10'	1.4 S	2.1 W	μ Sgr
M20	17h58.9m	-23°02'	en		25'	0.5 S	0.6 W	
6522	18h00.4m	-30°02'	gc	11.0	30"	0.4 N	0.5 W	γ Sgr
6528	18h01.6m	-30°04'	gc	11.8	30"	—	0.3 E	
6569	18h10.4m	-31°50'	gc	10.2	1-1/2'	1.4 S	1.7 E	γ Sgr
6558	18h07.0m	-31°46'	oc	11.3	1-1/2'	0.1 N	0.7 W	
M16	18h16.0m	-13°48'	oc/en	6.4	30'	0.8 N	2.5 W	γ Sgr
H19	18h14.5m	-13°18'	oc	12.2	5'	0.5 N	0.5 W	
6755	19h05.3m	04°09'	oc	8.3	10'	1.1 N	4.4 W	δ Aql
6756	19h06.2m	04°35'	oc	10.7	3'	0.4 N	0.2 E	
6723	18h56.2m	-36°42'	gc	6.0	6'	6.7 S	0.6 W	ζ Sgr
6726	18h58.4m	-37°00'	rn			0.3 S	0.4 E	
6818	19h41.1m	-14°17'	pn	9.9	1/4'	3.7 N	5.4 E	ρ Sgr
6822	19h42.1m	-14°53'	gal	9.2	16'	0.6 S	0.2 E	
M71	19h51.5m	18°39'	gc	9.0	6'	0.7 S	1.2 W	γ Sgr
H20	19h50.9m	18°13'	oc	9.6	10'	0.4 S	0.1 W	
6834	19h50.2m	29°17'	oc	10.3	4'	1.4 N	4.7 E	β Cyg
6842	19h53.0m	29°09'	pn	13.6	1'	0.1 S	0.6 E	
6939	20h30.4m	60°28'	oc	10.0	5'	1.2 S	1.7 W	η Cep
6946	20h33.9m	59°58'	gal	9.7	9'x7'	0.5 S	0.5 E	
7261	22h18.6m	57°50'	oc	9.8	6'	0.3 S	1.2 W	δ Cep
7281	22h22.9m	57°35'	oc			0.2 S	0.6 E	
7510	23h09.2m	60°18'	oc	8.8	2'	2.2 N	5.2 E	δ Cep
I1470	23h03.2m	59°59'	pn	8.1'	1	0.3 S	0.8 W	
M52	23h22.0m	61°20'	oc	7.3	12'	2.5 N	5.3 W	β Cas
7635	23h18.5m	60°54'	pn	8.5	3'	0.4 S	0.4 W	
7790	23h54.5m	60°56'	oc	7.1	6'	2.1 N	1.4 W	β Cas
7788	23h54.2m	61°07'	oc	9.4	2'	0.2 N	—	
H21	23h51.8m	61°29'	oc	9.0	5'	0.4 N	0.3 W	

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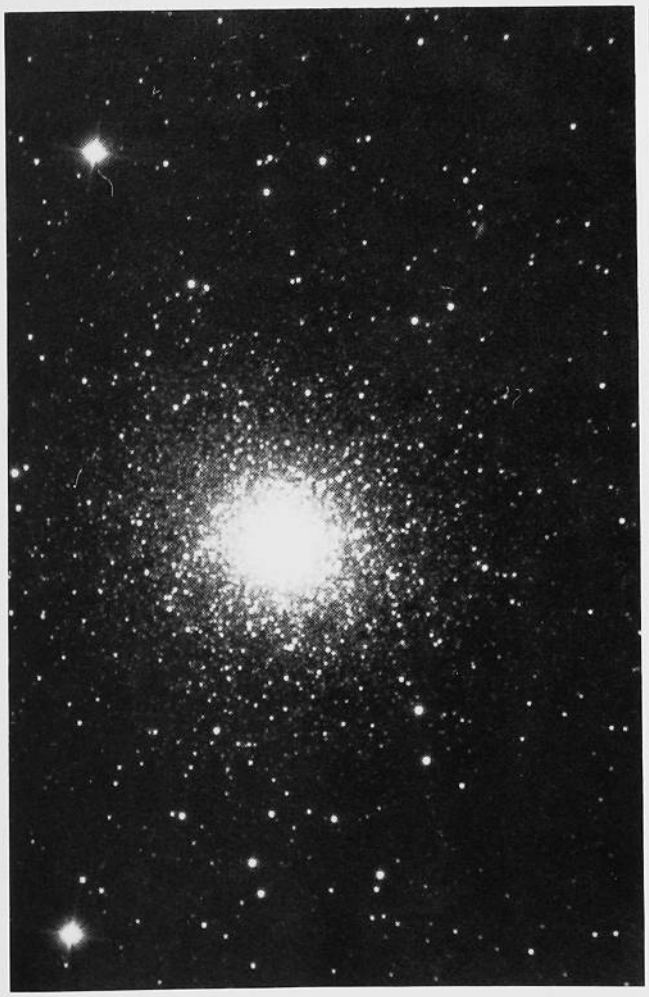
Norman, OK 73071



Top: Distant open cluster NGC 2158 lies practically inside the much closer and brighter cluster M35 in Gemini. Photo by Lee C. Coombs (10-inch f/5 reflector, 103a-O film, 10-minute exposure). Left: The faint galaxy NGC 6207 can be found near M13 in Hercules. Photo by Al Lilge (12.5-inch f/8 Pro-scope, 098 film, 120-minute exposure). Above center: Cluster NGC 6939 and galaxy NGC 6949 lie within a single wide field in Cepheus. Photo by Preston S. Justis (10-inch f/6 reflector, 103a-O film, 75-minute exposure). Above: The ring-shaped planetary NGC 2438 lies directly in front of cluster M46. Photo by Martin C. Germano (8-inch f/5 reflector, hypered Tech Pan film, 20-minute exposure).

Winter Deep-Sky Challenges

Taking Advantage of Crisp, Chilly Skies

by Phil Harrington

What's on your winter observing schedule this year? With the Milky Way blazing overhead, many observers take the opportunity to revisit some old friends scattered across the sky. Other amateurs prefer to stretch both their telescopes as well as their skills to their limits, thanks to frequent clear, dry nights. Still others find that the true challenge of winter observing is simply going outside for more than a few minutes and not freezing solid!

The objects featured here offer a good cross-section of the many challenging objects that are found throughout the winter sky. Why not try your luck with them? And once you've come back inside and had a chance to thaw out, drop me a postcard with your thoughts on these objects, as well as any other objects you feel might test other observers. Include as much information about your observations as you can.

A Naked Eye Challenge: the Pleiades (M45)

Stats: Open Cluster. R.A. 3h47.0m, Dec. +24°07′. Constellation: Taurus. Magnitude: 1.2. Size: 110′.

The Pleiades rank as one of the greatest challenge objects in the sky. For those imprisoned by all-consuming light pollution, the challenge is simply in finding the cluster's ill-defined smudge to the west of Aldebaran. Most suburban naked eye observers can count anywhere from four to six stars set in the shape of a tiny dipper. Slightly darker skies unveil a seventh star, permitting the group to live up to its nickname, the Seven Sisters.

Under dark, rural skies, the naked eye star count increases further. In all, twenty Pleiads shine at sixth magnitude or brighter, although some are too close to other stars to be resolvable without optical aid. The record holder for spotting the greatest number of naked eye stars in M45 is Walter Scott Houston, who recorded 18 from Tucson, Arizona back in 1935. Runner-up for the title is the late observer Leslie Peltier, who regularly noted between 12 and 14 Pleiads on moonless nights. On the next night, try your luck at Pleiades stalking, and see if you can equal these observational feats.

M78: A Challenge for Binoculars

Stats: Reflection nebula. R.A. 05h 46.7m, Dec. +0°03′. Con.: Orion. Mag.: 8. Size: 8′.

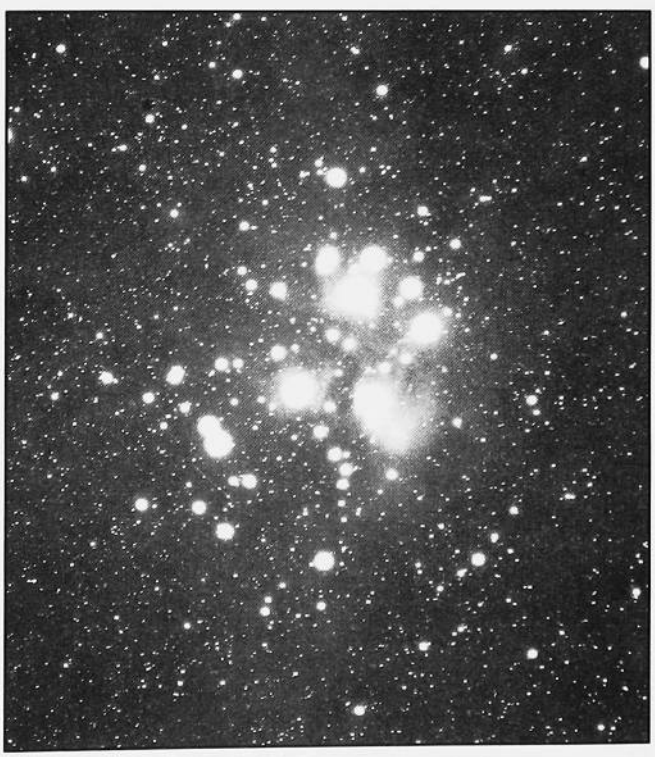
M78 (NGC 2068) is the brightest tip of a small "iceberg" of reflection nebulosity found 4° east of Mintaka (Delta Orionis), the westernmost star in Orion's belt. Discovered 210 years ago by Pierre Mechain, M78 appears like an oval smudge of grayish light that is slightly brighter on its southern end. Observers using large telescopes may see M78 as comet-shaped, with a broad tail of material arcing away from twin tenth magnitude stars in the head.

NGC 2071 forms a second tip to this iceberg. Though not likely to be seen through binoculars, this companion nebula is detectable in 3- to 4-inch telescopes as a faint glow northeast of M78. Bordering M78 to the southwest are NGC 2064 and NGC 2067. Both of these nebulae are only marginally visible in my 13.1-inch f/4.5 Newtonian.

Two to Three-inch Scopes: NGC 1990

Stats: Reflection nebula. R.A. 5h 36.2m, Dec. -01°12′. Con.: Orion. Mag.: ? Size: 50′.

This season's toughest challenge object is NGC 1990, an extremely faint reflection nebula in Orion. This object is easy to locate, since it surrounds Alnilam (Epsilon Orionis), the central star in the hunter's belt.



One of the finest naked-eye challenges is counting how many stars you see in the Pleiades. Photo by Jack Newton (300mm f/2.8 lens, hypered Tech Pan film, 15-minute exposure).

The low surface brightness refelction nebula M78 is a challenging object for binocular observers. Photo by Kim Zussman (11-inch f/10 SCT, hypered Tech Pan film, 90-minute exposure).

But seeing the nebulosity itself is another matter. Like the Pleiades nebulosity, NGC 1990 is dependent more on sky clarity, clean optics, and telescope collimation than it is on telescope aperture. The light from second-magnitude Alnilam tends to obliterate the delicate cloud if not viewed under optimum conditions.

I found this to be the case last winter. Observing at the Winter Star Party in the Florida Keys, I was able to detect its presence through both my 11x80 binoculars and 4.25-inch f/4 richest field telescope. Its slightly oval shape was distinctly seen through each, both with or without a nebula filter. Yet through other, larger instruments, all that could be seen was the glare of the star. Many people are fooled into thinking that this glare is the nebula itself, but it is simply scattered starlight caused by either poor optics or sky conditions. Wait for that next special clear night after the passage of a cold front, and then try your luck with NGC 1990.

Four to Six-inch Scopes: The Faint Planetary NGC 2371-72

Stats: Planetary nebula. R.A. 7h 25.6m, Dec. +29°29' Con.: Gemini. Mag.: 13p. Size: 0.9'.

NGC 2371-72 is a challenging object that always gives me trouble. I therefore present it as a challenge to observers with 4- to 6-inch telescopes (personally, though, I think its pretty tough in an 8-inch scope).

Its dim disk is located about 4° below the bright stars Castor and Pollux. Once located, it bears magnification well. Under high power, most observers note its twin lobe appearance, which gave rise to its dual listing in Dreyer's New General Catalogue. It might be appropriate to nickname it the "Littlest Dumbbell" in Perseus.

The southern lobe appears a bit brighter than the northern, with both glowing a faint gray. The nebular's 13th magnitude central star is not likely to be seen in anything less than a 10-inch.

Eight to Ten-inch Scopes: The Oddly Placed Galaxy NGC 1924

Stats: Galaxy. R.A. 5h27.9m, Dec. -5°19'. Con.: Orion. Mag.: 13p. Size: ?.

One of the nicest things about *Uranometria 2000.0* is that it brings to our attention many previously unknown objects. One good example is the galaxy NGC 1924. This 12th-magnitude object is located only two degrees west of the Orion Nebula, yet it is almost always ignored by amateur astronomers.

Although omitted from every modern observing handbook, it is faintly visible through my 8-inch f/7 Newtonian under exceptional skies. Its tiny, oval disk measures about 2'x1' across, with a faint stellar nucleus nestled within. The surrounding field is sprinkled with stars, which add to the attractiveness of this little known galactic treasure.

Twelve to Fourteen-inch Scopes: The Horsehead Nebula

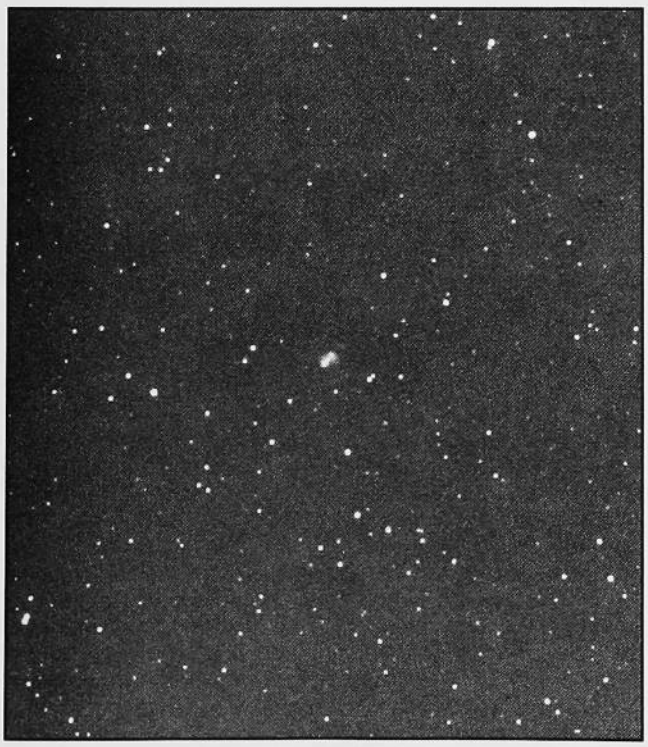
Stats: Dark nebula. R.A. 5h40.9m, Dec. -2°28'. Con.: Orion. Size: 6' by 4'.

Extending for more than a degree to the south of Alnitak (Zeta Orionis) in the hunter's belt is a faint dagger of diffuse nebulosity catalogued as IC 434. Due to its great breadth and low surface brightness, its detection can prove difficult through all backyard telescopes. The brightest portion of the cloud is visible near Alnitak, its exciting star, and fades away as one scans southward.

About halfway along IC 434 is the most famous dark nebula in the sky: the Horsehead Nebula. Visually, the Horsehead is also one of the most difficult objects to spy, due to its low contrast against an already faint diffuse nebula. To spot the Horsehead, first look carefully for the dim glow of IC 434's sharp eastern edge slicing the eyepiece field in half. If IC 434 is visible, then proceed to search for the Horsehead by first locating its exact position relative to nearby field stars. Personally, I always use a pair of double stars as a reference. One pair is southwest of B33, while the other is set to its northeast.

Although the Horsehead only covers an area measuring 6' by 4', it usually impresses people as being surprisingly large. Through my 13.1-inch f/4.5 Newtonian, I have seen its form clearly using a 12mm Nagler eyepiece and nebula filter. The horse's "mane" appears crisp and sharp, but its "nose" is a bit fuzzy. If you have never spotted this celestial nag, give the Horsehead Nebula a try on the next dark, clear night. It just might surprise you!

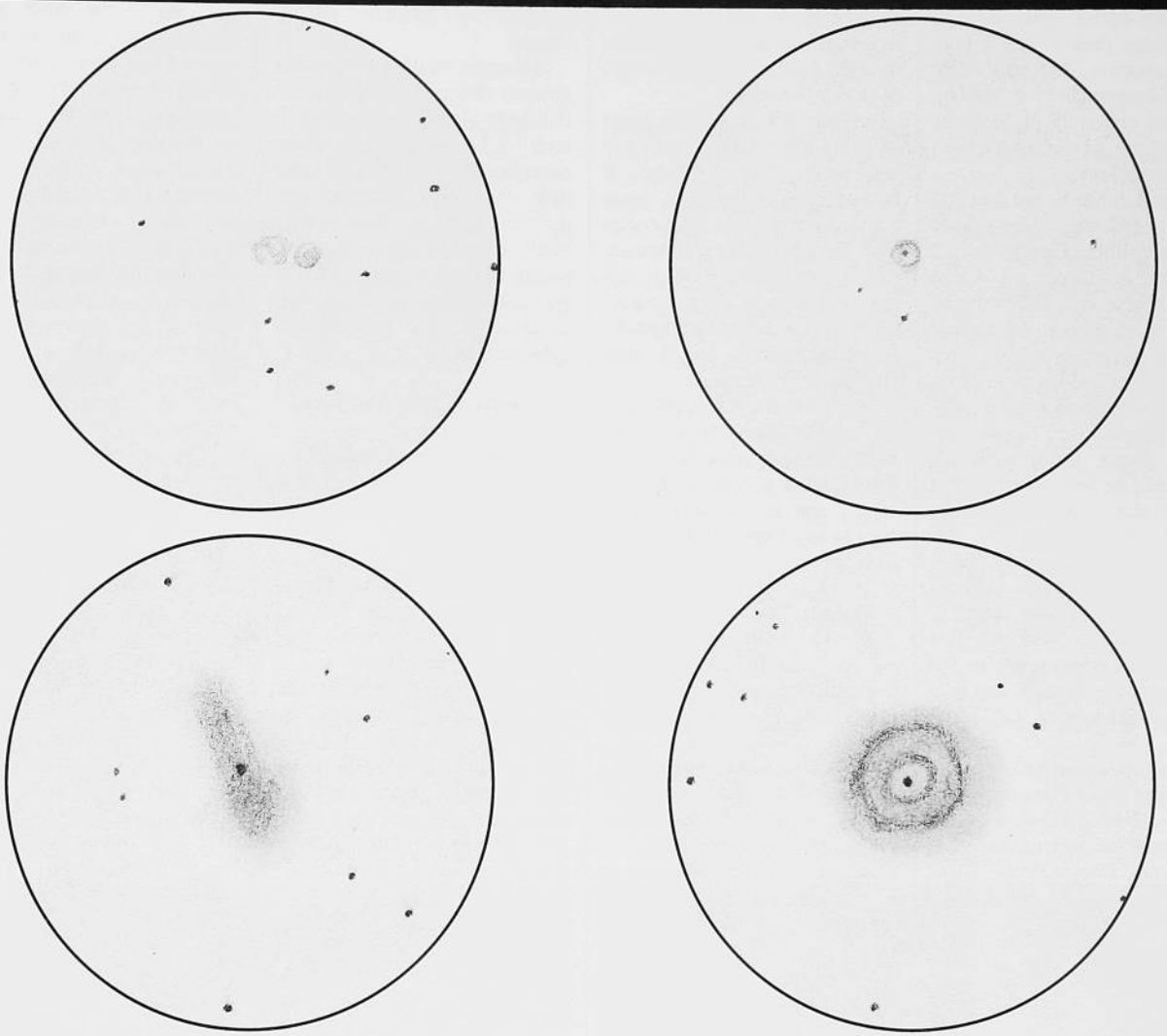
54A Dillmont Drive
Smithtown, NY 11787



Planetary nebula NGC 2371-2 in Gemini poses a challenge for owners of 4-inch to 6-inch telescopes. Photo by Tom Dessert (10-inch f/6 reflector, 103a-F film, 20-minute exposure).

The Horsehead Nebula is one of the ultimate challenge objects for large telescope observing. Photo by Martin C. Germano (8-inch f/10 SCT, 103a-F film, 120-minute exposure).

Reader's Page
Gemini's Treasures
by Steve Coe



Top left: NGC 2371-2 sketched by Dennis E. Hoverter (8-inch f/5 reflector at 150x). Top right: NGC 2392 sketched by A. J. Crayon (8-inch f/6 reflector at 200x). Bottom left: NGC 2371-2 sketched by Steve Coe (13.1-inch f/5.6 refelctor at 240x). Bottom right: NGC 2392 sketched by Steve Coe (13.1-inch f/5.6 reflector at 285x).

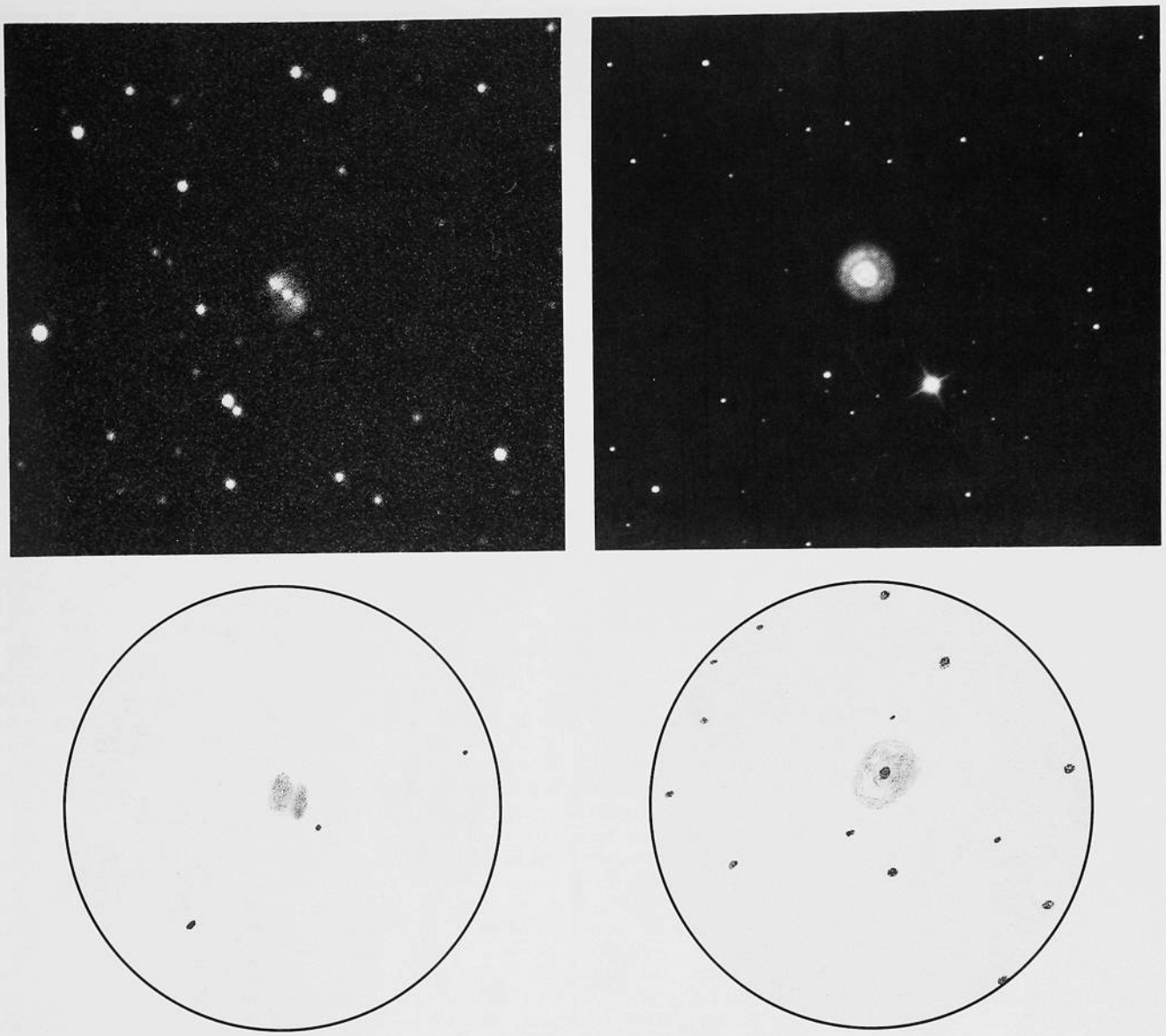
I can't believe it's already winter again. In Arizona we get quite a bit done during the winter. I know it is just too cold and stormy to observe in much of the rest of the United States and Canada, but out in the desert the nightly lows are usually around the freezing point. Winter skies are often the most transparent, providing many of the best views of deep-sky objects. So regardless of how warm or cold the night is, get out and take a look at some of the magnificent objects that reside in the sparkling constellation Gemini.

Measuring a mere 5' across, the open cluster **NGC 2266** is small, rich, and much compressed. At 100x in a 13-inch f/5.6 scope, I counted 50 stars at 165x, several of which are bright and quite prominently placed in the cluster. Steve Gottlieb of Albany, California, recorded that "NGC 2266 contains about 35 stars in my 13.1-inch scope, the brightest glowing dimly at 9th magnitude. Most of the stars are very faint." A. J. Crayon of Phoenix, Arizona, found that in an 8-inch f/6 scope NGC 2266 appeared "a little compressed, a little elongated toward the east, contains some twenty 13th-magnitude stars in a triangular shape."

NGC 2371/2 is a bright, large planetary nebula that is much elongated at 100x in the 13-inch scope. Higher powers bring out some structure: With 140x on a night I rated 7/10 for seeing and transparency, the nebula's southeastern end is much brighter and a central star can be held with direct vision. It is gray in color at all powers. Gordon Bond of Middlesex, New Jersey, used a 10.1-inch f/4.5 scope to observe NGC 2371/2. He found it to be "a small haze at 43x, appearing with averted vision almost like a double star embedded in nebulosity."

NGC 2392 is a bright, large, round planetary. Its central star is obvious at all powers in the 13-inch scope. At 200x the star is encircled by two rings, each containing several dark markings. These markings make the "face" that gave this object the name Eskimo or Clown Face Nebula. In the 13-inch scope the features are visible only on good nights. However, in my old 18-inch scope, the nebula's face was routinely visible. NGC 2392 has a distinctive light green color that is pretty much the same regardless of the telescope used to view it.

Steve Gottlieb observed NGC 2392 with his 17.5-inch scope and reported "a thin dark ring about two-thirds of the way out from the center, between the two shells. There is a darker hole in the inner shell. A bright, inner ring separates the two shells." With an 8-inch f/6 reflector at 200x, Crayon noted



Top left: NGC 2371-2 photographed by Martin C. Germano (8-inch f/10 SCT, 103a-F film, 45-minute exposure). Top right: NGC 2392 photographed by Jack Marling (24-inch f/15 Cassegrain, Fujichrome 400 film, 25-minute exposure). Bottom left: NGC 2371-2 sketched by Gordon Bond (10.1-inch f/4.5 reflector at 154x with O III filter). Bottom right: NGC 2392 sketched by Dennis E. Hoverter (8-inch f/4.5 reflector at 150x).

that NGC 2392 "is pale blue, has a ring structure, is a little elongated, and has a 9th-magnitude central star." Bond found that a 10-inch scope at 96x with an O III filter showed the Eskimo as "a large, bright disk with a subtle outer shell visible with averted vision. At higher powers the central star becomes evident."

NGC 2420 is a large, concentrated open cluster. I counted 30 stars at 100x in the 13-inch scope. An unresolved background of faint stars persisted at 165x. A chain of stars curves around the cluster's core and looks like a small copy of the constellation Corona Borealis. In an 8-inch scope, Crayon described NGC 2420 as "a very, very faint glow."

J900 is a planetary nebula characterized by being pretty faint and very small. J900 is visible at 100x and is gray-green in color. At 285x it is elongated in a ratio of 1.5:1. Averted vision is a must for seeing the most of this object. With his 13.1-inch scope Gottlieb recorded that J900 is "very small but nonstellar at 144x." Gottlieb continued that the object "takes high power well and shows an obvious disk at 214x. The object has a bluish tinge and a 13th-magnitude star lies close to the south." Bond found that his 10-inch scope at 43x showed J900 as "a faint starlike object, distinctive only when observed with an O III filter."

IC 443 is a large and extremely faint supernova remnant. I've found that it is so faint that it requires a filter to be seen at all. With a UHC filter this object appears like a dim wisp at 100x in the 13-inch scope. Using Chris Schur's O III filter raised the contrast, but it is still a difficult nebula. I would not have found this object without having the exact position from *Uranometria 2000*. Throwing a dark cloth over my head helped quite a bit. Even at a dark site, the "monk's hood" trick will focus your concentration on the view in the eyepiece.

Dave wants you to send in your observations of deep-sky objects we'll feature in the future. So you know what to sketch, here's the schedule.

Spring 1990: *Leo.* NGC 2903, NGC 3098, NGC 3162, NGC 3185/93, and NGC 3226/7.

Summer 1990: *Lyra.* M56, M57, NGC 6703, NGC 6765, NGC 6791, and PK 64+15.1.

Autumn 1990: *Andromeda.* NGC 68 galaxy group, NGC 404, NGC 752, NGC 891, NGC 7662, and NGC 7686.

Winter 1991: *Auriga.* NGC 1664, NGC 1857, NGC 1907, NGC 1893, and IC 410.

5942 West Loma Lane
Glendale, AZ 85302

Small Scope Showcase
A Regal Tour
by Alister Ling

Cassiopeia, our celestial queen, rides high in the Milky Way on winter's crisp nights. Like our earthbound queens, Cassiopeia proudly displays her prominent jewels. She also reveals a few hidden treasures only for her loyal admirers.

If there's one thing that comes to mind when I think of Cassiopeia, it's star clusters. In fact, there are few extragalactic objects visible in this constellation because the plane of the Milky Way with its absorbing dust cuts cleanly through the queen's center.

The only NGC galaxies to make it into Cassiopeia lie on its fringes, near the edge of the Milky Way. These are the familiar trio of NGC 147, NGC 185 and NGC 278, and the little-known NGC 1343, way north and weighing in at a measly 14th magnitude. The latter is ring-shaped, so big-scope owners may want to explore this faint fuzzy blob.

The "big three" clusters in Cassiopeia are M103, NGC 457, and NGC 7789. It is perhaps strange that M52 is so easily left out. One can be easily convinced that it belongs in the neighboring Cepheus! It remains a mystery how Messier could have seen M52 and M103 and yet missed NGC 457. A clue might be that it was Mechain who picked up M103. M52 was discovered by Messier who was following the comet of 1774 at the time. So the onus lies on Mechain.

I have always liked Ken Hewitt-White's hypothesis: perhaps Messier was afflicted with the flu during the cold winters. This, added to poor optics (he thought M52 was mingled with nebulosity), the continuing hunt for comets and the amazing wonders of the Orion region probably kept him from returning to Cassiopeia.

Commonly known as the Owl Cluster, NGC 457 is a perfect target for public star nights. Filled with bright, colorful stars, the Owl Cluster stands out well from the considerably fainter Milky Way. Like many other objects I mention in this column, NGC 457 is easy to draw. The curving patterns of the "body" and "wings" topped with the two "eyes" make it a snap to plot on paper.

NGC 7789 is quite the opposite, however. This large magnificent cluster is reminiscent of a loose globular cluster. I have yet to see a drawing that is remotely faithful to the eyepiece view. It is more easily understood how Messier and Mechain missed NGC 7789. Their scopes had poor definition and narrow fields. Also, NGC 7789's brightest star is more than two magnitudes fainter than M52's.

I wonder if my experience with NGC 7789 is similar to other observers. It never seems to be as good as I remember. Perhaps this cherished memory has been enhanced over the years by seeing photographs. Atmospheric conditions can also determine how well the cluster is resolved and how many faint stars can be seen. But don't let this distract you from taking a good look.

At more than twice the size and three times the number of stars of M103, NGC 663 is surely Cassiopeia's fourth crown jewel. Fittingly, I found NGC 663's shape to be a diamond. Three of the brightest stars are coarse pairs, while a good number of doublets and triplets lie scattered across the cluster's face.

Even from light polluted city skies it stands out quite well from the grey sky. Dark skies are required to add in the other fifty stars. In fact, I found that I could make a good sketch of NGC 663 by starting it in the city, then finishing it off in the country. An overall view of its eighty stars is rather dramatic and sure to stop all but the most dogged deep-sky sketcher. Why does M103 rank an M-number and not NGC 663? It boasts three stars much brighter than those of NGC 663, one of them a nice ruby. This is what caught Mechain's eye.

One gem you shouldn't overlook in this area is the tiny Trumpler 1. It is due west of NGC 663, and about three-fourths of a degree northeast of M103. I have to agree with Lucian Kemble who called it "one of the most charming clusters." That's what I like about open clusters — they have attributes other than brightness or size. Sometimes they're just nice to look at.

Trumpler 1 consists of two short lines of stars, not quite parallel. The northwest line, under close examination breaks up into doublets. The end star at the northeast end of the cluster is itself a nice pair. The group sits on a rich star field to cap off a delightful view.

Two "emeralds" on opposite sides of the W of Cassiopeia are the planetary nebulae Humason 1-1 and IC 1747. Both are plotted on Tirion's *Sky Atlas 2000.0*. The best aid for locating them is, of course, a narrow band nebular filter such as the O-III. What's the smallest telescope is required to see color in these planetaries?

I encourage all of you, especially those with a telescope drive, to sit and study IC 1747 with a keen eye for detail. At high power the planetary is very slightly elongated, barely north-northwest to south-southeast. How many of you will be fooled into seeing a different orientation by your own eye's slight astigmatism like I was?

IC 1747 is also annular, but the ring is fairly thick, and brightest on the north and south ends. Heber Curtis, who made a wonderful study of planetary nebulae back in 1918, noted that the central star glows at about 14th magnitude. I have not heard of amateur astronomers spotting this star. As I mentioned in my last column, using the highest of powers will hopefully fade the nebula enough for the star to shine through. Humason 1-1 shows a 5" disk elongated northwest-southeast. At 400x, I thought I could see a dark center. You'll have to wait for some steady seeing to see any detail here!

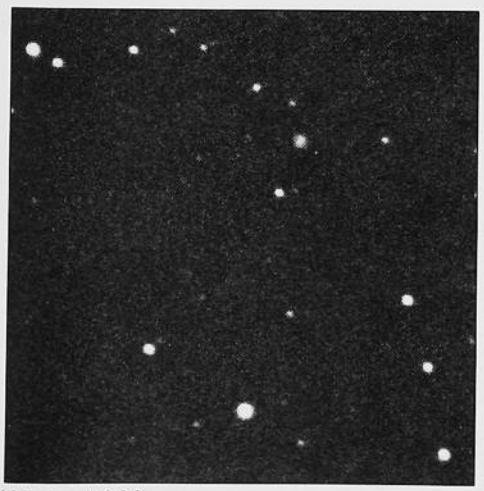
The final object in our tour of Cassiopeia's jewels is the emission nebula NGC 281. Star atlases show it as an inviting large blob. It has also been called the "Pac Man" nebula, because of its "C" shape. Rather large and faint, NGC 281 slipped through the narrow fields of the Herschels' telescopes, but was caught by the sharp eye of Barnard. The best view of this faint object comes with a good nebular filter. With the sky background pushed to black, the nebula's ghostly light becomes visibile.

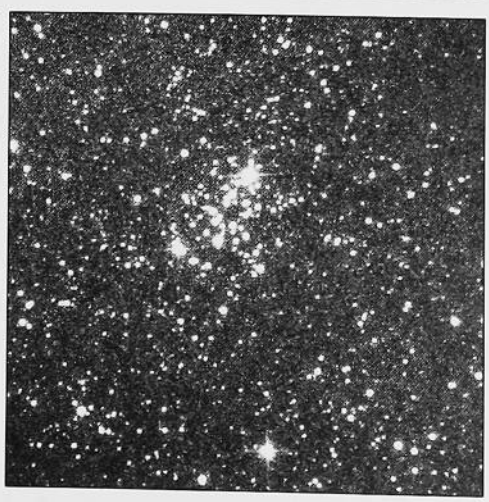
As an experiment, write down how far you can trace the nebulosity. As you push yourself, you will be surprised how an extra bit of staring extends the outer boundaries. Has anyone compared the views of NGC 281 through Hβ and O-III filters? I wonder if any surprises await as with M42.

Lying in the heart of NGC 281 is a most beautiful triple star. I was taken by surprise since no one seems to have mentioned Burnham 1. Walter Scott Houston did talk about this system, actually a quintuple, a decade ago, but observers are ignoring it while searching for the nebulosity. This is a prime example of how many amateurs miss fascinating sights by not using a range of magnifications.

Cassiopeia proudly displays her winter jewels high overhead. The diligent observer can undercover many more buried riches in her realm. Bring along your favorite atlases, nebular filters, eyepieces, and keep a lookout for diamonds!

1017 Seneca Avenue #310
Mississauga, Ontario
L5G 3X5 Canada





Above: NGC 7789 is the prettiest star cluster in Cassiopeia, containing over 200 faint stars in a cloud cover more than 30'. Photo by Martin C. Germano (8-inch f/5 reflector, 103a-F film, 10-minute exposure).
Far left: The bright cluster M103 can be picked up in binoculars. Photo by Lee C. Coombs (10-inch f/5 reflector, 103a-O film, 5-minute exposure).
Left: IC 1747 is one of the most challenging planetaries in the sky for small telescope users. Photo by Martin C. Germano (8-inch f/10 SCT, 103a-F film, 7-minute exposure).

Double Stars
E-Mail to England
by Brian Skiff

FROM: PERCY::BSKIFF
TO:
NAO::"ARGYLE%SRF.RGO.AC.UK"

Bob,

I just finished filing my latest batch of double star observations and decided to make a count of them, which I haven't done in more than a year. It comes out as 692 pairs in forty eight constellations; 288 of these are in twelve constellations where systematic observing based on a well-defined sample out of the *Sky Catalogue 2000.0, volume 2,* is complete. The card file box is getting full!

The "sample" consists of pairs in *SkyCat* between 0.5" and 10" with magnitude differences less than 3.0. These are not hard limits: for several reasons, pairs outside these limits are occasionally included, while others nominally within the boundaries are omitted. For instances, I find that I can recognize pairs down to well below the diffraction limit (about 0.85" for my 6-inch triplet refractor) as long as the secondary is brighter than about magnitude 7.5 at a reasonably small delta-mag. This limit drops to 1.0" at magnitude 9.0 (for the secondary), and to 2" by magnitude 10.5. Thus a pair listed in *SkyCat* with equal magnitude 8.5 components and a separation of 0.6" is usually passed over. I have managed to pick up a few of these, but they are taxing objects.

Also included are what I call "61 Cygni pairs," i.e. bright (both components brighter than magnitude 7), nearly equal pairs up to about 40" separation. These are not challenging or even interesting at high powers, but at very low power (30x on the 6-inch) they are often beautifully set in their fields. The star 61 Cygni itself, of course, dominates a marvelous star field. But similar pairs well away from the Milky Way are also remarkable in that they can be so isolated in fields with hardly any stars brighter than the threshold at low power.

Based on my card file of observations with the Lowell 24-inch Clark refractor, I find the limits just mentioned for 6-inches aperture to scale proportionally to 12-inches in terms of magnitude limits versus separation. Thus the three points for 12-inch telescopes are about 0.45" at magnitude 9.0, 1" at magnitude 10.5, and 2" at magnitude 12.0. The additional number of pairs accessible in such an instrument compared to the 6-inch is staggering. I've always been especially tempted by all those difficult close pairs with rapid orbital motion so frequent in catalogues of double star orbits. But they just are not visible in the 6-inch. Now the trick is to find an affordable diffraction-limited 12-inch!

Actually the Lowell Clark is essentially that instrument, used with its giant iris diaphragm. Stopped to 12-inches (f/32), there is far less chromatic aberration than in an ordinary refractor of the same aperture, and the seeing in Flagstaff is such that I can see the Airy disks on perhaps one out of five nights. There is naturally, a price: the Clark is not at all portable; just the tube and equatorial head weigh six or seven tons! Nevertheless, having been built at the end of the era of purely visual astronomy, it is a superb instrument, designed specifically for visual use.

I still prefer to use my little 6-inch under the truly dark skies at Anderson Mesa. My observing list for a typical night includes double stars and deep-sky objects, so I can sweep all of them up pretty quickly with the smaller instrument. The Clark is located above downtown, so while deep-sky observations might be well-executed, the bright sky means they are not representative of what a 24-inch can show.

Except for a few micrometer measures with the Clark (10 meters — 32 feet — of focal length is nice!), all these double star observations have been merely to check out these pairs for the fun of it. Well, there is a reason, actually. Looking at the usual observing guides for amateurs, one finds lots of information about the visibility of deep-sky objects but hardly anything about double stars.

Anyway, my idea is to survey all the bright and reasonably interesting doubles with the 6-inch in order to have a modern assessment of what there is to look at without having to extrapolate from cryptic comments in a publication whose sources are a hundred or more years old. Thus my observing notes for each pair include the lowest magnification at which the pair is resolved. This gives a clear idea of the difficulty of an object in this aperture.

I also estimate the position angle and the magnitude difference. Just using the Declination slow-motion knob on the telescope to define north-south in the eyepiece, I can get the position angle usually within five to ten degrees of the catalogue value. Occasionally, a close pair with rapid motion can be seen to be in a different orientation than given in *SkyCat* (where the most recent measure is typically thirty years old). Even rarer are the cases where an orbital ephemeris is seriously off — the pair will be obviously not as predicted! With some digging in the literature it is usually possible to find up-to-date measures that verify my visual estimates.

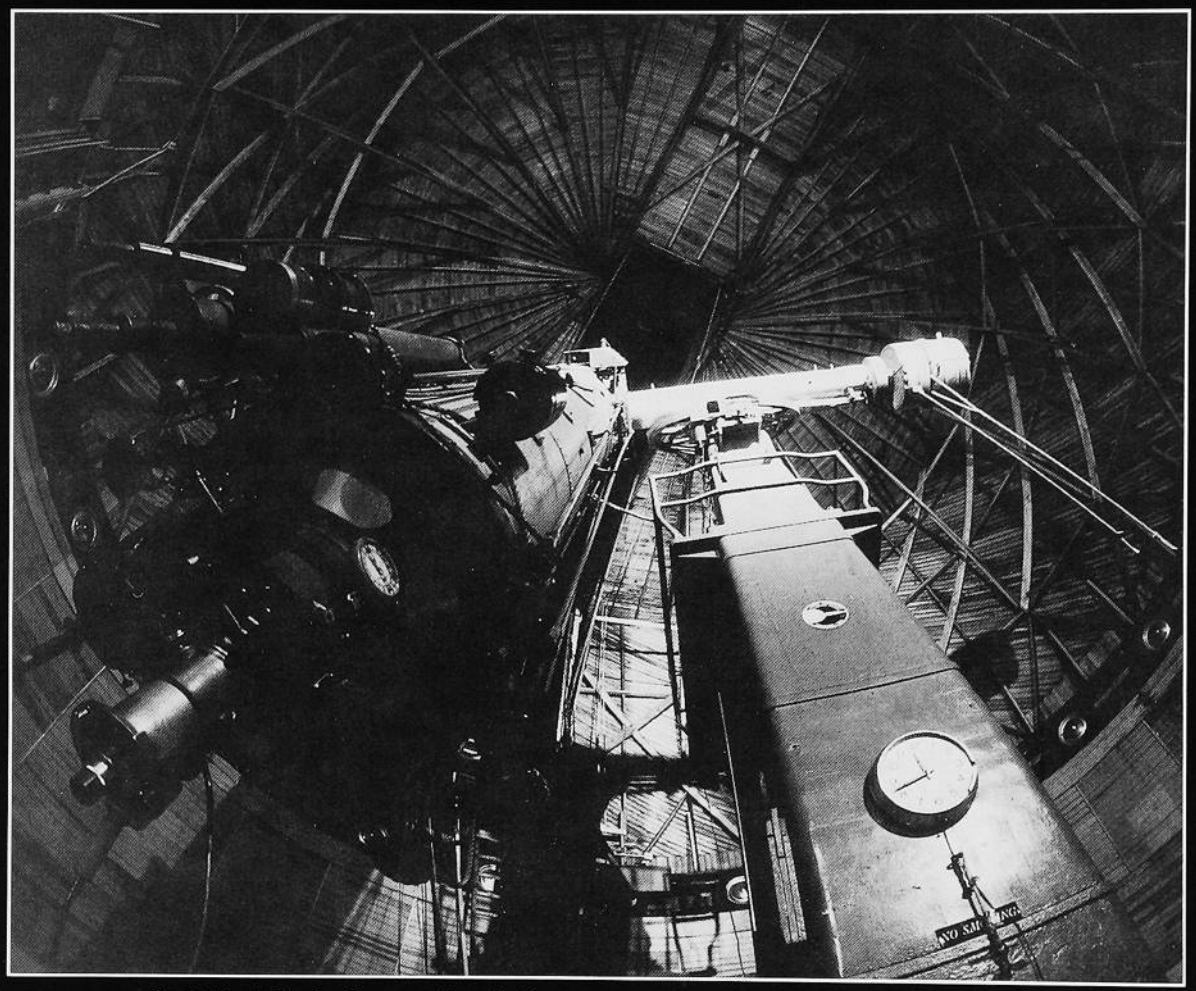
I estimate the magnitude difference also as a check on the catalogue values. Using experience viewing a number of "standards" as a guide, I can do this to within about a quarter of a magnitude at moderate Δm, but within a tenth or two at small Δm. Most of the catalogued values are okay, but about one in twenty or so, differ considerably. A very few of these could be variable stars, but probably the majority merely have bad numbers: somebody goofed somewhere along the way.

My Canadian observing buddy Paul Brown has a project to view all the *SkyCat* pairs listed with equally-bright components to see if they really are. This avoids the problem of calibrating your eyeball: the stars are equal or they're not! Although only partway through the list, he's finding a fair portion that do not live up to the claim of being equal.

Since I have an abiding interest in photometry, this sort of thing really gets me going. The only way nowadays to get good measures of the magnitude differences of doubles is with a CCD on a long-focus telescope. Since there are large numbers of relatively bright pairs, you don't need large aperture, just long focal length. The advantage of using a CCD as the detector is that you can get good astrometry as well as photometry as long as you have the computing power to analyze the images adequately and the telescope's optics are well behaved.

I'd like to get into doing CCD observing of doubles in the 2 to 10 arcsecond range, but just haven't made the time for it. It is these wider pairs that will become neglected in the future (thousands already are) as speckle interferometry becomes the method of choice for measuring those under two arcseconds, and the slower-moving wider pairs are abandoned by observers in pursuit of the rapid orbiters. These sorts of pairs need measurement only about once per decade (one good measure), so are an excellent field for amateur work, especially now that CCD systems are commercially available for use on small telescopes. I'll be waiting for your message — no rush.

Lowell Observatory
1400 Mars Hill Road West
Flagstaff, AZ 86001



The 24-inch Clark refractor at Lowell Observatory in Flagstaff, Arizona. Photo by Brian Skiff.

Variable Stars
Orion's Flock of Variable Stars
by David H. Levy

Although everyone says Orion is the most beautiful constellation in the sky, few Orion-gazers know that this constellation is prettier still when we appreciate the stars in it that fluctuate in brightness. Unknown to many observers, the famous constellation has a beautifully rich variety of variable stars, representing all types of variation.

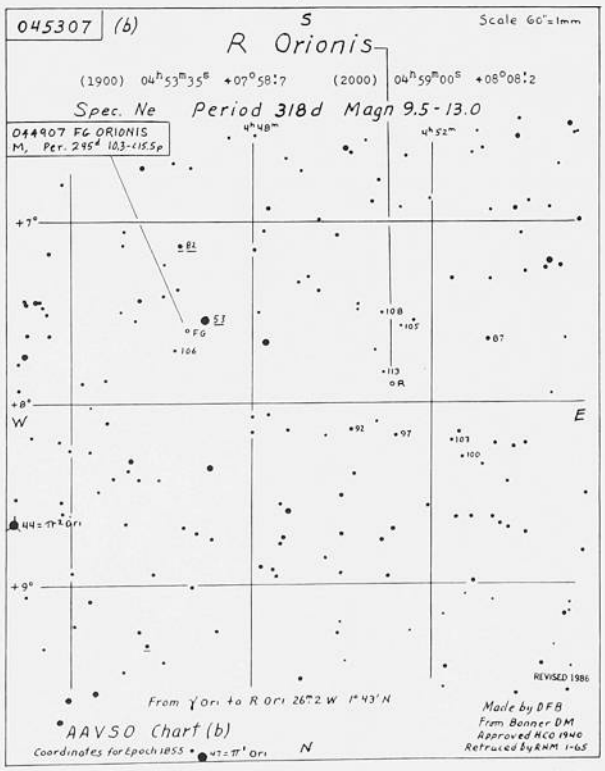
The first star in Orion discovered as variable is 045307 **R Orionis**, a ruddy, Mira-type star with a period of 378 days and a range of over four magnitudes. At maximum R Orionis typically shines at magnitude 9.6, although it has been observed as bright as magnitude 9.1. The star's minimum magnitude averages 13.1, with extremes to magnitude 13.4. R Orionis' red color comes from its N spectral class. As this column has often mentioned, be careful when observing such red stars — look with quick glances instead of prolonged stares. If you stare, you'll get the illusory impression that the star is brightening as you watch it. Another bright Mira star is 0524-04 **S Orionis**. This star's variation slowly cascades over six magnitudes from 8.4 to 12.9. S Orionis' period of 419 days is one of the more leisurely of the long period variables, which means you don't have to estimate its brightness more frequently than once every two weeks.

The third earliest known variable in Orion is 0530-05 **T Orionis**, a star of a completely different type. Situated right near the middle of the Orion Nebula, T Orionis is a nebular variable, an eruptive star whose irregular flickering may have multiple causes. Shortly after its discovery, astronomers thought that T Orionis varied in brightness as clouds of nebulosity passed in front of it. This theory became obsolete, however, when observers noted irregular flickering of up to a fifth of a magnitude in just ten minutes. Now it appears that the stars intrinsically vary in brightness, either by themselves or due to some interaction with their immediate environment. In addition to the rapid variations, T Orionis undergoes larger drops in brightness of up to four magnitudes. The pattern, in fact, is reminiscent of R Coronae Borealis, with long periods of near-constant variation followed by precipitous drops that can last several months.

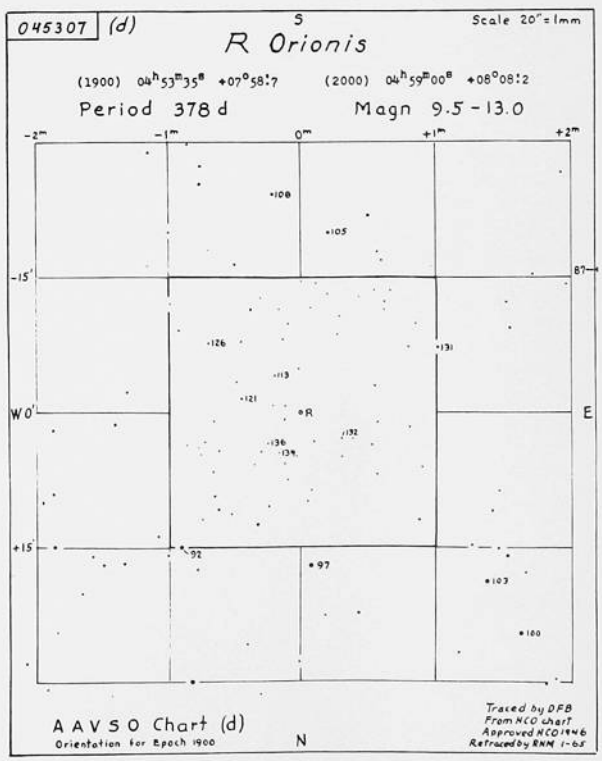
Although most nebular variables are early stars, class B, A, or F, some are of other classes. The unusual star 0530-05 **V363 Orionis**, for example, is an M star that lies in the Orion Nebula.

With this plethora of nebular variables, it seems as though other types of variables might be lacking in Orion. Not so: there is a nice vareity of variables in Orion. For example, 054920 **U Orionis** is an easily found long-period star in the far northern region of the constellation. At maximum U Orionis can reach magnitude 5.3, making it briefly a naked eye star. However, over a period of a little over a year — 372 days, to be exact — U Orionis can drop to as faint as magnitude 12.6. The average variation, 6.3 to 12.0, is slightly less extreme. Another interesting star, **V371 Orionis**, is a UV Ceti star that typically glows at 12th magnitude but occasionally outbursts to 10th.

It can be argued that 053909 **FU Orionis** is the most interesting variable star in the constellation. First, its place in the middle of a dark globule indicates that it was surrounded by a lot of unlit gas. For much of its observed history, FU Orionis appeared on photographic plates as a faint star of photographic magnitude 16.5. (Pho-



This chart for R Orionis is handy for use with binoculars. All charts reproduced by permission of Janet A. Mattei, director, AAVSO.



A telescopic chart for R Orionis has south at top and shows the star surrounded by faint standards.

tographic magnitudes are usually, but not always, fainter than visual by about one or two magnitudes.) This star's rise, perhaps half a century ago, to magnitude 9.7 took place over only three months, and the star remained near that magnitude for almost two years. A very slow fading then started. According to the *GCVS*, FU Orionis was down to magnitude 10.3 by 1966.

Astronomers' impressions of what caused this irregular behavior have changed along with the star. The initial rapid rise of FU Orionis was reminiscent of a nova, and the star was considered a nova for some time. However, novae almost always decline with relative speed (staying at maximum for two years and falling very slowly is not typical of a nova at all). Now FU Orionis is thought to be an example of a star in a very early evolutionary phase.

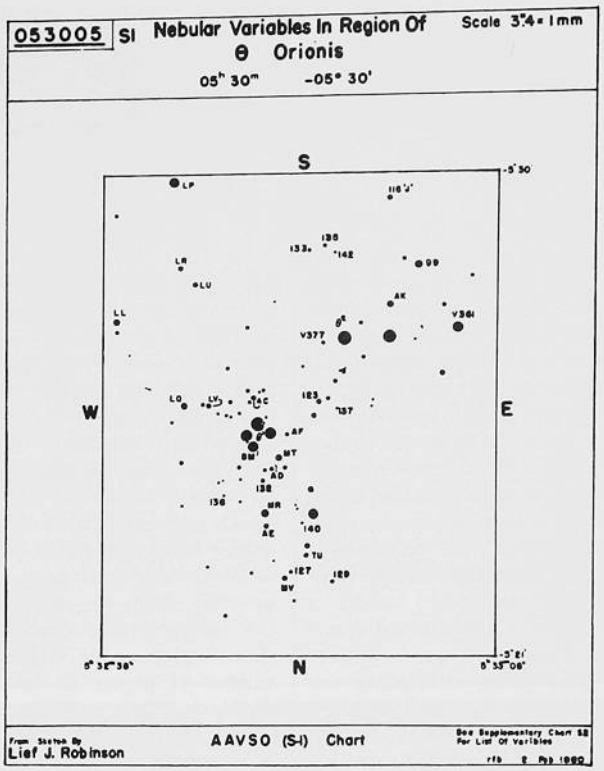
Orion even has some eclipsing binaries. One of them, 0530-05 **BM Orionis**, is involved with the Trapezium. It varies from magnitudes 8.0 to 8.7 over 6.47 days. Another is **Theta[1]**, a member of the Trapezium, which was found not too many years ago to be an eclipsing binary with eclipses spread out over unusually long periods.

There are a few bright semiregular stars in Orion. For example, 050001 **W Orionis** ranges from magnitudes 5.9 to 7.7 over a period of 200 days. Similarly, 052504 **CK Orionis** varies very slightly from magnitudes 6.2 to 6.6 over 120 days, and 052707 **RT Orionis** changes from magnitude 9 to 11 over an unknown period.

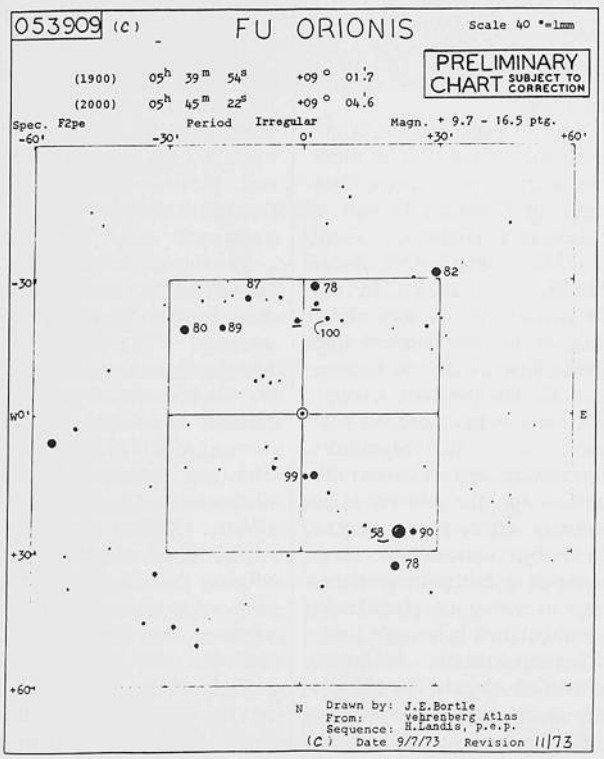
Finally, Alpha Orionis itself, **Betelgeuse**, is a semiregular star whose leisurely variations from magnitudes 0.4 to 1.3 stretch over an approximate period of 2,070 days, or about five and two-thirds years. Although a variation this long over so small a range would not appear to be worth watching visually, in reality that is not the case. Changes of half a magnitude or more can take place over several weeks. A problem, of course, is finding comparison stars that are the same altitude as Betelgeuse, so that atmospheric extinction of stars far from the zenith will not affect your estimate. Procyon (magnitude 0.5) and Pollux (magnitude 1.2) sometimes work.

Few Orion gazers know the constellation is laden with variable stars.

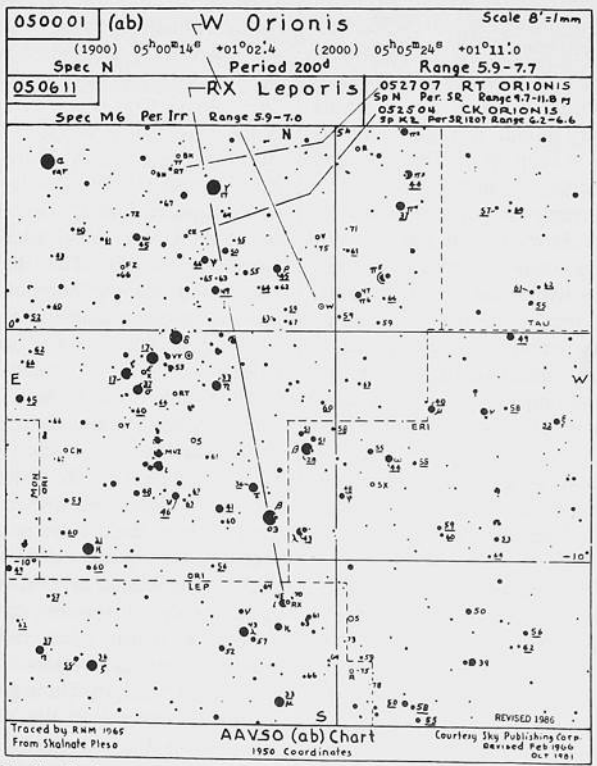
120 William Carey Drive
Tucson, AZ 85747



Numerous nebular variables lie within the heart of the sword of Orion.


053909 (C) FU ORIONIS
Scale 40 '=1mm
PRELIMINARY CHART SUBJECT TO CORRECTION
(1900) 05h 39m 54s +09° 01'.7
(2000) 05h 45m 22s +09° 04'.6
Spec. F2pe Period Irregular Magn. + 9.7 - 16.5 ptg.
Drawn by: J.E.Bortle
From: Wehrenberg Atlas
Sequence: H.Landis, P.O.P.
(C) Date 9/7/73 Revision 11/73

A preliminary chart for the erratic variable FU Orionis approximates a low-power telescopic view.


050001 (ab) W Orionis
Scale 8'=1mm
(1900) 05h00m14s +01°02'.4 (2000) 05h05m24s +01°11'.0
Spec N Period 200d Range 5.9-7.7
050611 RX Leporis
Spec M6 Per Irr Range 5.9-7.0
052707 RT ORIONIS
Sp N Per SR Range 9.7-11.8 pg
052504 CK ORIONIS
Sp K2 Per SR 1101 Range 6.2-6.6
Traced by RNM 1965
From Skalnate Pleso
AAVSO (ab) Chart
1950 Coordinates
REVISED 1986

This "naked eye chart" shows the locations of the variables W Orionis, RT Orionis, CK Orionis, and RX Leporis.

Scanning the Literature
Keeping Up with Science
by Brian Skiff

One of the more daunting tasks that faces professional astronomers is keeping up with the journals. Most people keep up, if at all, only with the papers published in their specialty, and are unfamilar with much else. Usually what one ends up doing is making a bibliographic search (using a computer database) on a specific topic relevant to whatever reserach one is preparing for publication or for a conference, and ignoring everything else.

This policy of finding our only what you need to know and only when you need to know it is a perhaps lamentable but necessary consequence of the volume of science being done nowadays. The five principal journals in astronomy (*Astronomical Journal, Astrophysical Journal, Astronomy & Astrophysics, the Monthly Notices* of the Royal Astronomical Society, and the *Publications of the Astronomical Society of the Pacific*) publish most of the best current science, and a quick estimate gives a total of about 2.5 million words printed in these five journals every month. It might be possible to keep up with this, but you wouldn't do anything else.

Nearly half of this total is in *The Astrophysical Journal,* still the journal-of-record for astronomy worldwide. In recent years, a typical issue has consisted of five hundred or more pages, a hefty phone-book's-worth of astronomy every two weeks! The thick issues are difficult to photocopy and when two are bound as a numbered volume for libraries, they are unwieldy and liable to rip from their backing.

To ameliorate these problems, *Astrophysical Journal* will appear three times each month starting in January 1990, so each issue will be a mere 450 or so pages. Production economies put into place several years ago mean that the subscription rate and page charges will remain the same for now.

Astrophysical Journal started in 1895 with ten thin issues each year (annual subscription: $4.00), but soon dropped to six issues per year, which held steady until the early 1960s. Then the increase in the amount of science done due to the *Apollo* program dictated the frequency be increased in steps up to the present semiweekly rate by 1971. With the decline of U.S. space science funding, a major source of the increasing number of papers in the last decade has been contributions from foreign astronomers, who now represent about one-quarter of the authors. The 1989 volumes of *ApJ* will span about 3.5 feet of shelf space, all for only $480 per year. (If you're a member of the American Astronomical Society, you can fill up your office for only one quarter of the price).

In the last issue, I mentioned two new catalogues concerning galaxies. Well, now the grandaddy of them all has appeared, and it behooves us to add a new acronym to follow on *NGC, UGC, MCG, CGCG* and *RC2*. It is the *PGC*, for *Principal Galaxy Catalogue* ("An Extragalatic Database. I. The Catalogue of Principal Galaxies;" G. Paturel, et al.: *Astron. & Ap.* **80**:299, November 1989). This basic catalogue is a compilation of all previously catalogued galaxies, totalling a little over 73,000 objects.

The paper cited here is merely a description: the catalogue itself totals nearly 900 pages. Included in the listings for each object are positions (half to better than 10 arcsecond accuracy for equinox 1950 and 2000), magnitudes as available on a variety of systems, morphological types, sizes, radial velocities, position angles, and cross-identifications. During the course of generating this list, the authors tracked down an extensive collection of misidentifications, which they will publish separately later. The *PGC* is the source for the forthcoming *RC3,* a more selective and complete working catalogue of data to be published by the University of Texas.

A basic catalogue of galaxies in the region of the Fornax cluster has also been published ("Population Studies in Groups and Clusters of Galaxies. II. A Catalog of Galaxies in the Central 3.5° of the Fornax Cluster." Henry Ferguson; *Astronomical Journal* **98**:367, August 1989). The list totals 2,678 objects as faint as magnitude 20 (complete to about B magnitude 18) in a 40 square degree area found on plates taken with the DuPont 2.5 meter telescope at Las Campanas in Chile.

Photographic photometry was performed on a UK Schmidt plate covering the area. Of the total, only 340 galaxies are likely members of the cluster, with the remainder lying in the background (there are essentially no foreground objects). The catalogue provides accurate positions, types, magnitudes, and cross-identifications for all the objects.

Another paper dealing with a catalogue of galaxies is blessedly short "A Photometric Catalogue of Compact Groups of Galaxies;" P. Hickson, E. Kindl, and J.R. Auman; *Ap.J. Suppl.* **70**:687, August 1989). This article provides photometry of 463 galaxies in one hundred tight groups first selected by Hickson in 1982. The list (only a couple of pages) includes precise positions, total B magnitudes, dimensions, and cross-identifi–cations for the objects. Like ordinary clusters of galaxies, these objects provide the visual observer or astrophotographer a way to view (or photograph) several objects in a single field.

Among papers discussing individual objects, an interesting recent one concerns Arp 118, also known as NGC 1143 and 1144 ("Arp 188: An Interacting System with Extreme Velocity Gradients;" H.H. Hippelein; *Astron. & Ap.* **216**:1, June 1, 1989). CCD images and spectra taken with the 3.5 meter telescope at Calar Alto in Spain were analyzed to examine the consequences of the interaction of the two objects in Cetus (2000: 2h 55.2m, -0°11').

NGC 1144 is a much-distorted spiral, while NGC 1143 is a smaller, but evidently undisturbed elliptical or S0 galaxy. Both glow at about V magnitude 13, and have radial velocities of about 8,500 km/sec — they are unquestionably related in space. The unusual aspect is that the spiral has a rotational velocity of over 700 km/sec (i.e., one side of the galaxy has a velocity lower than the other), much higher than is typical for ordinary spirals (where 300 km/sec is typical). The arms of the galaxy show many bright "starburst" HII regions arranged in a ring-like pattern, presumably as a consequence of the interaction, and appear to be shredding apart.

The author made some computer models of galaxies colliding, finding that a good match could be made if NGC 1143 is about 1/3 the mass of the spiral and plowed almost centrally through it about twelve million years ago.

The third of three recent studies of cluster membership of stars in the Orion Nebula has appeared ("A Proper-Motion Membership Analysis of Stars in the Vicinity of the Orion Nebula;" B.J. McNamara, et al; *Astron. J.* **97**:1427, May 1989). The two earlier studies were discussed here in *Deep Sky* #25 (Winter 1988/9).

This work covers 630 stars brighter than B magnitude 14.0 in a seven square degree area centered on the nebula, and excludes the bright central region, which is well covered by the previous work. Rather than using plates taken with long-focus refractors and reflectors, this study used plates taken

Stars in the vicinity of the Orion Nebula have been thoroughly studied by B. J. McNamara in his recent paper in Astronomical Journal. *Photo by Dan Gordon.*

Site	Brightness	Δm
Mt.Wilson	19.85	2.14
Lick	20.65	1.33
Palomar	21.53	0.46
Kitt Peak	21.91	0.08
McDonald	21.98	0.01
Mt. Lemmon	21.59	0.40[1]
Lowell (Mars Hill)	20.52	1.48
Lowell (Anderson)	21.84	0.16
Mount Graham	21.94	0.05
Siding Spring	21.99	0.01
Cerro Tololo	21.98	0.01
David Dunlop	18.42	3.59[2]

[1]calculated for moderate Tucson smog.
[2]using 1986 data for Toronto and vicinity population

A compilation of galaxies called the Catalogue of Principal Galaxies *was recently published in* Astronomy & Astrophysics *and contains 75,000 entries. Photo by Robert Provin.*

with the 40cm Harvard Metcalf astrograph. More than three dozen plates taken at each epoch (about 1910 and in 1987) were measured to derive the proper motions.

The article includes charts identifying the stars along with another fat catalogue including coordinates, magnitudes, the proper-motions and corresponding membership probabilities, and (thankfully) cross-identifications to the star names.

The stars involved with the Orion Nebula are, of course, quite young, and a color-magnitude diagram of the secure members shows the consequence: practically all stars fainter than V magnitude 9.0 (or spectral type A) lie above the main sequence-they are still contracting out of the nebular medium-and are certainly variable to some degree.

Professionals are as concerned about light pollution as amateurs. Apart from making measures of how the sky brightness is changing for the worse at most observatories and doing their fair share of complaining, an interesting recent paper provides a way to predict the degree of brightening caused by cities and natural skyglow for any site ("Night-Sky Brightness at Observatories and Sites;" Roy Garstang, *Publications* of the Astronomical Society of the Pacific **101**:306, March 1989).

This article summarizes the author's extensive work modelling the effects of cities and skyglow in terms of the light scattering properties of the atmosphere. In general, his models are remarkably accurate in matching actual measurements taken at various observatories. Using the model, he provides a long list of sky brightness predictions and measurements for both established observatories and for potential sites that may be developed in the future.

Some results for famous observatories and sites is given below. These apply to the zenith only, although Garstang provides values for specific directions away from the zenith. The population of nearby cities affects the results strongly, of course, so all these values (except for David Dunlop Observatory) apply for the year 1980, the latest for which it is easy to get population statistics. By comparing these, you can get a feeling for how growth affects the values.

The baseline for a pristine site at minimum solar activity (another strong factor in sky brightness) is V = 21.99 per square arcsecond, which corresponds to V = 13.10 per square arcminute. The amount of brightness above natural is indicated under the Δm column. Most of the sites listed here are fairly dark. Those with more than 0.5 magnitude of additional artificial skyglow would not be considered "dark" for the amateur observer.

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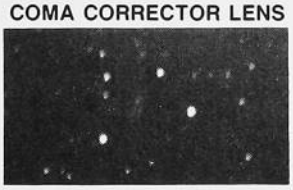

Coma 1 inch off-axis (17½" f/4.5)

Same Field with LUMICON coma corrector lens; note smaller, more numerous stars.

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2" Easy-Guider™ (state camera)	**$169.50**

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2111 Research Drive #5T Livermore CA 94550
For phone orders please call (415) 447-9570
LUMICON Products catalogue $2.
Foreign orders add $8 ($20 for HYPER-KITS)
California Residents add 6% tax.
Prices subject to change w/o notice.

NEW! ENCHANCED SILVER DIAGONAL MIRRORS BOOST TELESCOPE PERFORMANCE

LUMICON 1.3" & 3.1" enhanced silver diagonal mirrors & 2" star diagonal.
The new LUMICON diagonal mirrors have a special enhanced silver coating with a protective overcoating for long life. Visible reflectivity is 98-99% compared to 86-89% for standard aluminum coated mirrors. The extra 10-12% transmission is like adding an inch of aperture! The substrate is fine annealed Pyrex flat to 1/8 wave.

1.32"	**$29.95**	1.52"	**$34.50**	1.83"	**$39.50**
2.14"	**$49.50**	2.60"	**$65.00**	3.10"	**$89.50**

ENHANCED SILVER STAR DIAGONAL

90° star diagonals with above enhanced silver mirrors in a CNC machined black anodized aluminum body. Performance far exceeds prism diagonals.

1¼" (1.32" mirror)	**$99.50**
2" (1.83" mirror)(see photo above)	**$159.00**

OXYGEN-III FILTER

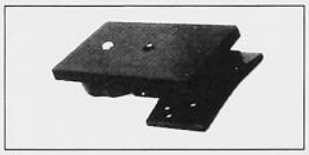
Helix Nebula, NGC 7293 in Aquarius. Bright and easy with Lumicon Oxygen-III Filter.

The ultimate in filter performance! The Lumicon Oxygen-III Filter has a contrast twice as high as the high performance Lumicon UHC Filter™. Use the Oxygen-III Filter for observing the very faintest planetary and diffuse emission nebulae. Also gives incredible views of bright nebulae (like M-27, M-17, etc.) from urban locations. Bandpass is 11nm, transmission is 90% for both O-III lines at 496nm and 501nm.

Filter Type	1¼"	48mm
Lumicon Oxygen-III	**$99.50**	**$199.50**
Lumicon UHC	**$99.50**	**$199.50**
Lumicon Deep-Sky	**$79.50**	**$119.50**
Set UHC and Oxygen-III	**$190.00**	**$380.00**

NOTE: The Oxygen-III Filter is not a substitute, but a compliment to the UHC Filter. **1 year guarantee:** You must see nebulae with the O-III filter that are **invisible** without a filter.

NEW ADJUSTABLE PIGGYBACK MOUNT



LUMICON has just designed a new adjustable piggyback mount ideal for all telescopes of 8-14" aperture. It has **both** vertical and sideways adjustment to allow optical alignment. It was designed to allow mounting of the LUMICON SUPER-FINDER on C-8, C-14, etc., but is ideal for any telephoto lenses or small telescopes.

Deluxe Piggyback Mount **$54.00**
(State Telescope Type)
LUMICON 12x80mm SUPER-FINDER $195.00

NEW! LOW PROFILE HELICAL FOCUSERS

LUMICON® DELUXE NON-ROTATING HELICAL FOCUSER on a 6" telescope.
LUMICON now offers 3 different low-profile helical focusers. They stand only 1¼-1½" above the telescope tube. Use the 1¼" or 2" versions for viewing. Use the 2" non-rotating focuser for convenient photography with the LUMICON 2" EASY-GUIDER™.
Select your desired base-plate shape!
Flat, 7" OD, 9½" OD, 12½" OD, 16" OD, 21" OD, SUPER-FINDER base plate.

LUMICON 1¼" Helical Focuser	**$49.50**
LUMICON 2" Helical Focuser	**$59.50**
LUMICON Non-rotating Helical Focuser	**$89.50**
3 handles (see photo) for non-rotat. focuser	**$12.95**
2" Rack & pinion low profile focuser	**$129.00**
2"/1¼" adapter w/48mm filter threads	**$20.00**
2" LUMICON EASY-GUIDER	**$169.50**

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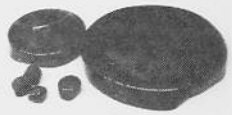

Protective plugs (left), vinyl dust covers.
Protect your valuable telescope optics, eyepieces and accessories with these black vinyl covers. Add $1 shipping. Deduct 10%, 2 or more sets.

1¼" O.D. plug, seals focuser	**4/$2**		
2" O.D. plug	**2/$2**	3½" O.D. plug	**$1.50**
1¼", 1⅜"	**3/$2**	7½"	**$8**
1½"	**2/$2**	9½", 10.4"*	**$12**
2"	**2/$2**	12½", 12⅞"*	**$15**
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5½"	**$6**	19" (DS-16)	**$35**
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†U.S. Patent 4,473,636

MAKE YOUR OWN HYPERED FILM

MODEL 300 HYPER-KIT sensitizes any 35mm film in hours. Best for 2415. Achieves highest possible film speeds **$295.00**

MODEL 600 HYPER-KIT (See Photo) Like the Model 300, but also sensitizes 120/220 larger format film and small glass plates **$350.00**

MODEL 1200 HYPER-KIT is for 4X5" plates and film up to 5X7". Has 2 gas cylinders and includes temperature controller **$595.00**

Temperature controller for any HYPER-KIT **$65.00**

Electric Vacuum Pump **$319.00**

GUIDE OFF-AXIS FOR LOVELY ASTROPHOTOS

All **LUMICON EASY-GUIDER™** off-axis guiders† have both radial and 360° rotational adjustments for 5X easier guide-star selection, use 48mm filters, 360° camera rotation, large prisms of bright guide-starts. *Specify Camera and Telescope type.*
U.S. Patent #4,448,500

NEWTONIAN EASY-GUIDER™

Full aperture. Installs in secs. Specify 2" or 1¼".

NEWTONIAN EASY-GUIDER	**$169.50**
3X Relay Diagonal (see photo)	**$89.50**
Illuminated reticle eyepiece system	**$99.50**
Guider for Hasselblad **$350**, Mamiya 645	**$199**

CASSEGRAIN EASY-GUIDER™

For C-8, Meade 2080, Dynamax-8. Includes 50mm achromatic lens for f/5.8 operation —3X shorter exposures! **Superb rich field viewing, too!**

CASSEGRAIN EASY-GUIDER	**$225.00**
Adapter for Hasselblad $185, Mamiya 645	**$98**

GIANT EASY-GUIDER™

For Celestron-11, C-14, and the 10" Meade 2120. Includes 80mm clear aperture achromatic lens for edge-to-edge illumination & pin-point star images. F-ratio adjustable f/4-f/11. **Also yields unmatched Rich-Field viewing.**

GIANT EASY-GUIDER	**$395.00**
48mm DEEP-SKY Filter ordered with any EASY-GUIDER (SAVE $20)	**add $99.95**
Adapter for Hasselblad adapter **$195**, Mamiya 645,	**$119**

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1. Illuminated reticle eyepiece **$99.50**
Lumicon 12mm eyepiece system has adjustable L.E.D. illumination, dual crosslines, battery pack.

2. Cable release for long exposures .. **$9.95**

3. **LUMICON Quartz Drive Corrector . $219**
Dual-axis drive corrector is essential for astrophotography and/or field use of your telescope. 40Hz/80Hz variable output controls telescope drive. 60Hz Quartz reference ±12VDC Declination control output. Both 110VAC and 12VDC input for home or field use. Declination reverse switch for Newtonians.
Declination motor (state telescope) .. $99
NEW Deluxe Digital Qtz. Drive Correc. **$298**

HYPERSENSITIZED FILM

LUMICON Hypersensitized film is essential for good deep-sky astrophotography. Deduct 10% for 3 or more rolls (mixed o.k.).

Film Type, 35mm	Exposures	Price
2415, Ultra-fine B&W, red sens.	36	**$10.95**
SR3200, fastest of all, color neg	24	**$13.95**
Konica SR400, fine gr. color neg	12	**$10.95**
3M 1000, fastest slide film	20	**$12.95**
Fujichrome RD100, fine gr. slide	24	**$12.95**
5072, color slides from negs	36	**$6.95**
D-19 B&W Developer	1 gal.	**$6.95**

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GALAXY'S ULTIMATE IMAGE™ full thickness (1:6) and lightweight mirrors (2.00") are made from Precision annealed *molded* Pyrex mirror blanks and are available with a choice of two outstanding reflective coatings.

COATING #1: 88% Reflectivity - Aluminized and quartz overcoated
COATING #2: 96% Reflectivity - Broadband multilayer dielectric coating over aluminum

FULL THICKNESS 1:6 OPTICS

MIRROR	COATING #1	COATING #2
10"	$ 375	$ 425
12.5"	525	600
16.0"	1700	1950
18.0"	2300	★
20.0"	3400	★

LIGHTWEIGHT 2.00" THICKNESS OPTICS

MIRROR	COATING #1	COATING #2
14.5"	$ 850	1050
16.0"	1100	1350
18.0"	1300	★
20.0"	1650	★
22.0"	2970	★
25.0"	4950	★

GALAXY'S ultra-lightweight mirrors (1.6") are made from fine annealed Pyrex mirror blanks and are manufactured to the same specifications as our 1:6 mirrors.

ULTRA-LIGHTWEIGHT 1.6" OPTICS

MIRROR	COATING #1	COATING #2
14.5"	$ 725	$ 925
16.0"	950	1200
18.0"	1100	★
20.0"	1400	★
22.0"	2450	★

★ Enhanced aluminum coatings by special request only.

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MINOR AXIS	COATING #1	COATING #2
2.1"	$ 75	$100
2.6"	75	100
3.1"	95	120
3.5"	265	300
4.0"	285	325
5.0"	425	475

All mirrors are available in many popular focal ratios. Full thickness (1:6) and ultra-lightweight Zerodur® Optics available. Mirror refiguring services, write for quotation. For a complete product catalog mail $1.00 to:

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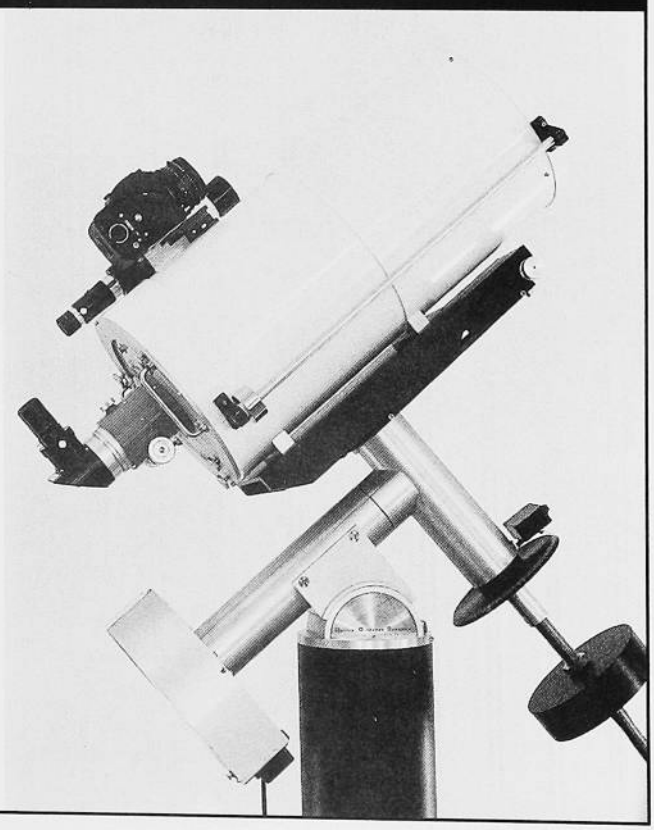

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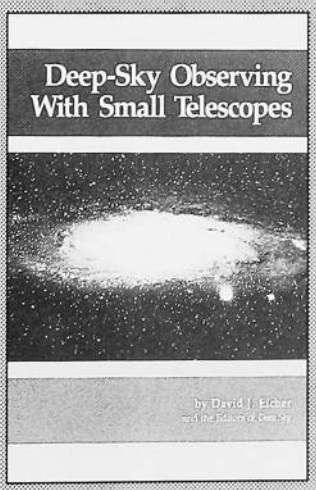
by ASTRONOMY's Assistant Editor David J. Eicher and the editors of* Deep Sky *magazine



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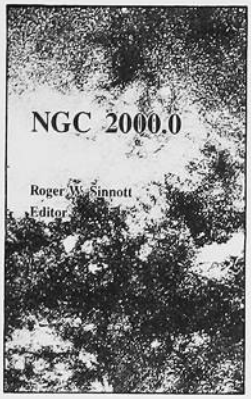

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1. maximum reduction in coma and field curvature without compromising spherical aberration and color correction

2. major sharpness improvement for all popular focal ratios

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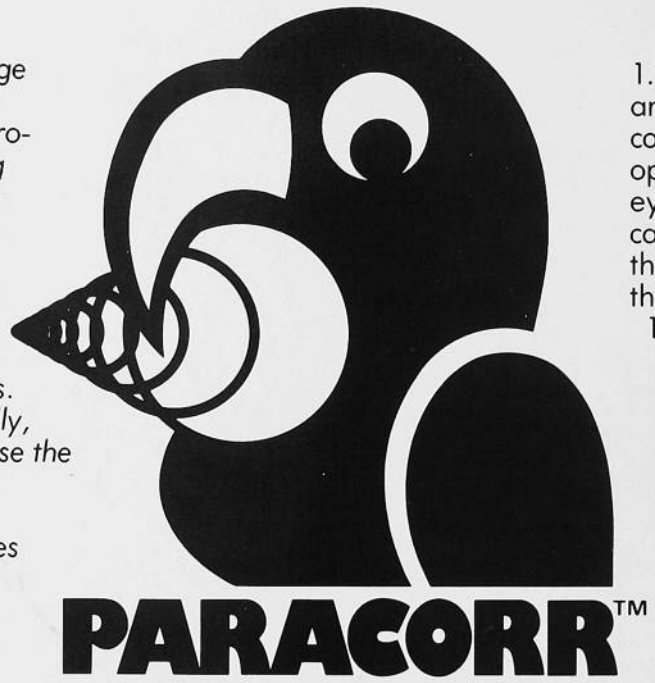
I hope you agree that Paracorr, the coma eater, is the missing link necessary to fully enjoy your "DobNewt."

—Al Nagler



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